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PRELIMINARY REPORT ON THE YALE NORTH INDIA EXPEDITION

By Dr. H. DE TERRA

YALE UNIVERSITY

SCOPE OF THE EXPEDITION PLAN

THE idea that geological and biological sciences may support each other in research on related problems may at first appear strange, especially if they are supposed to cooperate in a task of exploration in a region so little known as the Himalayas. However, for me, who had explored formerly as a geologist in western Central Asia and northern India, it seemed quite obvious that a study of fresh-water life in these highly elevated mountain ranges would help to throw new light on the geographical conditions of the Himalayas during the Pleistocene and postglacial periods. For it was in comparatively young geological times that the Tibetan plateaus and the adjoining highlands were uplifted to form the "Roof of the World," and it was to be expected to find a peculiar faunal character with endemic forms which would reveal faunal relations to Central Asia or to India.

The geological work was to be focused on the study of those diastrophic events which resulted in the earth's highest mountain structure, north of peninsular India. Investigation of such a wide scope which was to be carried out on difficult territory required careful selection of particularly promising mountain sectors. These were to be found in Kashmir proper, where a thick Pleistocene sequence of strata in a structural basin could furnish evidence on Pleistocene orogeny. On the other hand, the eastern Karakoram, north of the Himalayas, seemed to be most profitable for an investigation of the structural outlines of this northern neighbor of the Himalayas. Geomorphological observations were to support the structural studies. A topographical survey was to facilitate this work. Finally, there was a good chance for collecting vertebrate fossils in the richly fossiliferous Siwalik formations south of the Himalayas.

Owing to the great interest which this plan of mine found at Yale, and thanks to the kind support it received by its President, of Professor Ch. W. Warren, dean of Sheffield Scientific School, of Pro-

fessors R. S. Lull and R. G. Harrison, I could start with the field work on March 1, 1932.

The biological work had been entrusted to Mr. E. G. Hutchinson, assistant professor of biology at Yale; the paleontological collecting to Mr. G. E. Lewis, of the Peabody Museum at New Haven. Temporary additional members of the staff were: Mr. A. M. N. Ghosh, of the Geological Survey of India, and Khan Sahib Afraz Gul Khan, surveying officer of the Survey of India.

Collecting and Studies in the Salt Range

The first field trip led to the Salt Range in the Punjab, where each of the members pursued their own scientific tasks. Following a personal request from Professor Charles Schuchert, of Yale University, a collection of invertebrate fossils in the well-known and highly fossiliferous Permian and Triassic limestones of the Salt Range was to be made. Owing to the generous help of Dr. L. L. Fermor, director of the Geological Survey of India, Mr. Ghosh from the Survey was made available for this work. He collected first under my supervision and later independently near Warcha, Amb and Chideru. New sections of the Permian formation were also studied at these places, and it is hoped that these new data will throw additional light on the age of the Permian glaciation. In Professor Schuchert's opinion this collection turned out to be very satisfactory, as almost all Waagen's types and additional genera are represented.

Hutchinson studied some salt lakes on the central plateau of the Salt Range northwest of Kushab. The paleontological collecting continued in the area of the upper Soan River until the middle of May.

Geological and Biological Work in Kashmir

On March 18, my wife, Mr. Hutchinson and I moved from the Punjab to Srinagar, Kashmir. This city through its central location in the Kashmir Valley made a convenient place for expedition headquarters. Here camp and other additional equipment could be purchased for the summer trip to western Tibet and the Karakoram Ranges. Furthermore, all excursions into the Kashmir Valley, be it by houseboat, car or pony caravan, could be arranged from Srinagar. Hutchinson spent from March 24 until May 10 on the large lakes: Dal-, Anchar-, Manasbal- and Wular-lake and on the Jhelum River as well. I could almost devote the same amount of time, though frequently interrupted by preparations for the coming summer trip, to the geological study of the Valley of Kashmir. Middlemiss had already found through former studies that the so-called Karewa formation (Pleistocene) of the Kashmir Valley had been disturbed and folded along the southern flank of the basin. The exact age of these clay, sandstone and gravel series had since Godwin Austin's time always been disputed. Lack of fossil evidence and of a closer field study prevented the stratigraphic classification of these interesting strata which evidently had taken part in Hamalayan diastrophism. During the spring and later again in the fall of 1932, I found several new and highly important fossil localities in the Karewa. In gray fat clays, presumably belonging to an interglacial period (of Illinoian-Wisconsin age), I found three rich plant localities. Prominent amongst the plants are, besides *Alnus, Populus, Quercus,* the genera *Buxus, Trapa* and *Charophytes,* and Cinnamon, indicating a climate similar but somewhat warmer than Kashmir enjoys nowadays. These plant-bearing clays were found overlain by moraine material of the last glacial stage. The upper Karewa beds yielded a great number of fresh-water shells, plants, and the remains of a straight tusked Proboscidian. The latter was found near Sombur, being probably the first Himalayan representative of a mammoth. Only six miles distant from this locality I came across some prehistoric artefacts lying in the upper Karewa beds. On another locality I believe to have found similar, although somewhat doubtful, implements. As not only the lower but also the upper Karewa have been tilted and dragged high upward along the Pir Panjal Range, it seems obvious that a diatrophic phase of late Pleistocene, and even possibly of later date, resulted in renewed uplift of the flanking Himalayan Ranges in the region of the upper Jhelum River. This uplift may be estimated from 6,000 to 8,000 feet.

Hutchinson's work in the lakes in Kashmir resulted in a large collection of fish and various fresh-water forms and in gathering chemical and other biological data. The faunal character appeared to be different from that of the Indian lowlands, with quite a number of endemic forms. As the ancient lake beds of subrecent and Quaternary origin contain a great number of fossil shells, it should be possible to find considerable amount of evidence on the late Pleistocene-alluvial history of the Kashmir Lake basin.

Expedition Activities in the High Himalayas and Eastern Karakoram

Around the middle of May the expedition members united at Srinagar to prepare for the start to the highlands of western Tibet. A caravan carrying food and biological apparatus was sent ahead to Leh, capital of Ladakh, in the upper Indus Valley. Khan Sahib Afraz Gul Khan, our surveyor, with his two servants, had joined us here and we all left Srinagar on May 16. Within two weeks we crossed the northwest Himalaya on the "High Treaty Road" into Ladakh, and arrived at Leh on June 2. An excursion to the great monastery of Hemis proved to be a unique

experience, as we witnessed the lamaistic mystery play. This short trip into a side glen of the Indus Valley brought me also a large collection of old Tertiary plants, of which I had found a few traces during my first journey in 1927. On June 21, we left Leh for the Panggong Lake and crossed the southern Karakoram Ranges, taking the route *via* Digar- and Shakya Pass (18,100 feet) to Tankse and Lukong. The great Panggong lake basin (13,915 feet), extending from Ladakh into the Tibetan province of Rudok, and containing one of the largest, high mountain lakes north of the Himalayas, afforded good possibilities for our geological and biological work. The lake, now salty, must have been a fresh-water lake of considerable depth and extension during the last interglacial period. Shell-bearing lake beds containing fish vertebrae are overlain by morainic boulder. As in the case of the Kashmir Valley, the fossil remains of fresh-water life will help to reconstruct the changes in biological conditions during postglacial times.

From the Panggong an excursion led to the high valley of Koh-lungpa (17,250 feet) and across the main Karakoram Range to Ororotse Tso. This lake (17,383 feet) was found still solidly frozen on July 12, but it proved to be very rich in fresh-water life. The main axis of the Karakoram Range, bending here from a northwest-southeast into a west-easterly trend, was crossed a second time on our way to the upper Chang-Chenmo Valley (17,000 feet). A line of higher snow peaks, all ranging over 21,000 feet in altitude, was found continuing south of this valley toward the Tibetan frontier, where it gradually passes over into a broken line of monadnock-like snow massives surmounting the western Tibetan plateau. This range is regarded by me as the easternmost outpost of the high Karakoram Range. Our route led us from here along the Tibetan frontier *via* Nyagzu back to the Panggong Lake.

The geological structures in this part of the Karakoram are characterized by heaving, folding and steeply inclined thrusts; the latter being between nice granite and metamorphic rocks on one hand, and fossiliferous young Paleozoic to marine Triassic and Cretaceous formations on the other. The pressure of folding must have acted vertically, but from the Mustagh-Karakoram Range on northward it seems to have thrown the folds towards Central Asia. In comparison with my former observations, I am inclined to believe that the southern Karakoram Ranges (Mustagh- and Kailas-) represent "root-zones" of large thrusts, while the adjoining highlands between the northern Karakoram and the K'un-lun Mountains are made of lesser folded portions of the Himalayan region. Evidences of thrusting on a large scale were also found in the northwest Himalayas near Karghil, where thick Triassic limestone series have been moved upon Cretaceous formations. These observations, of which only very little can be related on the occasion, lead me to believe that the geological structure of Himalaya and Karakoram is dominated by thrusting in alpine fashion. Although it still remains to be seen whether this thrusting led to a regular "Deckenstructure," the evidence rather leads to the conclusion that these highest mountain ranges show themselves not only morphologically but also structurally as true alpine ranges, which have been folded up from the bottom of the former Tethys Sea at various times in intervals from the close of the Cretaceous up to the close of the Tertiary period. The geomorphic features of this highest relief are composed of four main elements: (1) Remnants of a preglacial relief consisting of plateau relicts and piedmont levels between 16,000 and 20,000 feet altitude. (2) Glaciated high ranges and massives (20,000 to 22,000 feet), surmounting the former widely extended plateaus. (3) The glacial relief which dominates the landscape. (4) Postglacial features bearing evidence of wide-spread and most intense rejuvenation of rivers through broad uplift at intervals.

It was surprising to find plenty of evidences for a recent rise in the lake level of most high mountain lakes. This became especially apparent along the shores of Panggong and Tso Moriri Lake, where trigonometrical stations, religious buildings, roads and lower beach levels had been inundated by what appears to be a recent increase in precipitation. It is to be hoped that these observations, together with Dr. Haude's meteorological work in Central Asia (Swedish-Chinese Expedition of Sven Hedin), will help toward an ultimate solution of the problem of the "desiccation of Central Asia." From the Panggong we worked our way southward along the Tibetan frontier to the Pongur Tso, to Chushul, the Indus Valley, Moriri Lake in Spiti, and back to Leh.

The total route of 1,300 miles by pony and caravan, with nine important mountain lakes on our way and 4,600 square miles of newly surveyed territory, gave us ample opportunity to follow the original plan of field researches. Much credit for this undisturbed field work has to be given to my companions, my wife and Professor Hutchinson, and to our surveyor, who in spite of his strenuous work was always willing to assist me greatly in expedition matters.

During my geological investigations a great number of invertebrate fossils were collected. Aside from limnological material and a number of smaller mammals a few hundred plants have been gathered by Professor Hutchinson. He also succeeded in getting many data on the ecology of the invertebrate ground fauna at altitudes over 17,000 feet. "It is hoped,"

he says, "that a study of the zoogeographic realm of the invertebrates living at high altitudes will throw much light on the history of these regions. As far as it is possible to judge at present, the rather large number of species endemic to these elevated regions argues against any wholesale glaciation of the region."

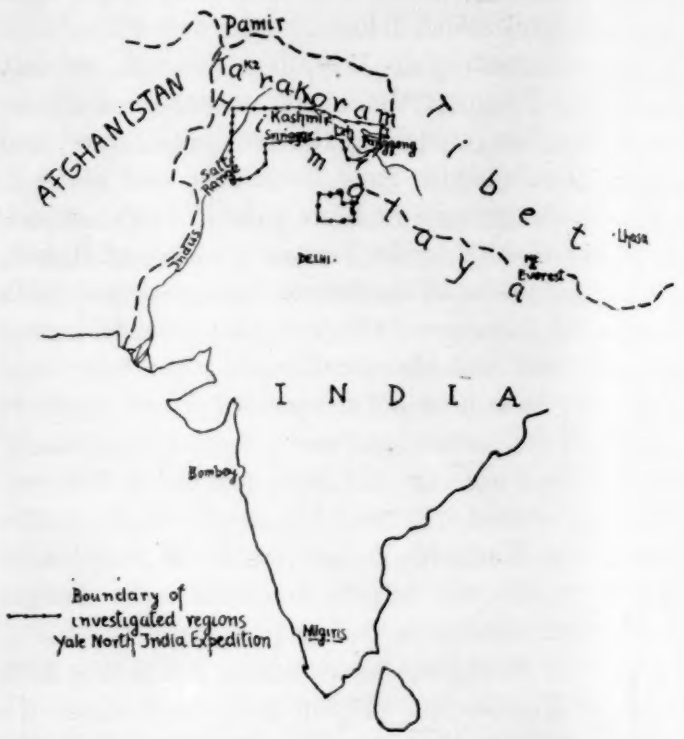
The expedition returned from Ladakh to Srinagar, Kashmir, on October 2.

VARIOUS ACTIVITIES OF THE EXPEDITION UNTIL JANUARY, 1933

During the last five months the various expedition members were busy in Kashmir, the Punjab, Calcutta and the Nilgiri Hills of southern India. Although the latter region was out of the general field of our studies Hutchinson was anxious to get some zoogeographical data on the fauna of the Nilgiris in relation to the "pluvial relict" hypothesis.

Mr. Lewis, who had started back in June to the more promising fields of the Siwalik formations, collected in Bilaspur State in the Simla Hills and adjacent portions of the Punjab. He also worked in the Siwalik Hills proper, from the Sutlej River to the Kaluwala Rao near Dehra Dun (United Provinces). He reports about his results as follows, "An abundance of excellent material was collected in the time available, and in addition to the large vertebrate fauna numerous invertebrates and paleobotanical specimens were secured; all of which will be added to the collections of the Peabody Museum of Natural History of Yale University."

My field work in Kashmir continued until November 23 and was then transferred partly back to the Salt Range and partly to the Siwalik foothills in the Rawalpindi district. The last excursion to the southwestern Salt Range undertaken for the sake of the tilted Pleistocene strata made me come across a prehistoric site. This was discovered first by Mr. Hutchinson, who had done biological work on the salt lake Kalakahar. A second locality was found near-by on an ancient lake terrace with three layers of implementiferous soil containing coup de poing, scrapers and rejects of presumably early paleolithic age. A human skull was found in between the upper two



layers. With the kind permission of the director of the Indian Archeological Survey I was able to collect these traces of what appears to be the earliest settlement of prehistoric man in India.

Around the middle of January, 1933, the field work of the expedition was terminated and the members left India shortly after. The scientific collections have safely arrived at New Haven and shall be worked upon by the members of the expedition and with the aid of scientific experts.

As this undertaking was being carried out in countries which offer many natural hindrances to scientific exploration, the success of the expedition was due in great part to the help of the Government of India and various Indian scientific institutions. I greatly appreciate all the support that has been so generously extended toward us by British-Indian government officials.

H. DE TERRA

YALE UNIVERSITY

A HISTORY OF THE NATIONAL RESEARCH COUNCIL 1919–1933

III. DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH[1]

By Professor DUGALD C. JACKSON

CHAIRMAN

THE Division of Engineering was established as one of the Council's divisions in 1919 for the purpose of organizing and coordinating engineering research in industry. Its membership consists of representatives

[1] This is the third of a series of ten articles prepared to describe briefly the nature of the activities with which the National Research Council has been engaged during the past fourteen years.

from the national engineering societies and certain members-at-large.

The following persons have served as chairmen, beginning with the period immediately before the formation of the division from a committee of the Council:

1918– —Henry M. Howe
1919–1921—Comfort A. Adams
1921–1923—Alfred D. Flinn
1923–1927—Frank B. Jewett
1927–1930—Elmer A. Sperry
1930–1933—Dugald C. Jackson

During the first period of its life, from 1919 to 1923 inclusive, the principal object of the division was regarded as getting more and better research done in the engineering field, avoiding the rôle of dictatorship or of assuming credit for work which it encouraged others to do. The division headquarters were established in the United Engineering Societies Building in New York City on invitation of the Engineering Foundation and the four Founders Engineering Societies, for the purpose of intimate association with the national engineering societies.

The second period of the division, from 1923 to 1927, was one of transition. Numerous research projects which had their roots in wartime requirements were completed, and their committees were discharged to clear the decks for project activities to meet current needs.

After the Division of Research Extension was merged with the Division of Engineering in 1924, an attempt was made to balance the activities of the division between research projects *per se* and promotional efforts. The organization then was quite unique. It was a pioneering effort, with few precedents. A director and a secretary of the division were selected to guide the work of the division under the supervision of the chairman and executive committee.

In the period 1927–1933, the third of division life, research projects already started have been continued. A variety of new ways has been found for increasing effectiveness in bringing to the attention of the public, and of specialists like industrialists and bankers, the value and benefits of research in the industries. A change in the character of the promotional activities of the division from "why" to "how" do research during this period is also significant.

The major work of the division can be classified best under two main headings: (1) research projects and (2) promotion of research.

The gradual evolution of a research-project policy and the development of procedure in the administration of research projects undertaken for study has been indicated. In the conduct of several of these projects the division has been fortunate in the cooperation of other divisions of the Council. In others its quasi-governmental standing has stood it in good stead in securing the cooperation of governmental departments. It has always had the whole-hearted support and cooperation of the interested engineering societies.

It obviously would be impossible in the space allotted to this report to describe even in brief detail each of the more than fifty research projects which have been completed during the past fourteen years or which are now under way. Two examples (one, the marine piling investigation from the list of completed projects; and the other the Highway Research Board, from current work) are therefore here selected to illustrate project policy, method of conducting project work, and the significance of results obtained.

A section of the San Francisco Bay contained many large and valuable structures, which had been erected on unprotected wooden piles over a period of several decades. In 1914 it was found that a species of shipworm previously unknown in those waters had attacked the dikes at the entrance of Mare Island Navy Yard and other structures in the bay. In 1917 signs of serious damage appeared in the dikes. Within the next four years practically every timber structure in the vicinity was damaged, with losses estimated at $15,000,000.

The National Research Council was requested to organize a study on a nation-wide scale. A national committee was formed to study the preservation of wooden structures from the attack of marine borers, and to conduct an investigation into the value and proper use of various substitutes for timber. Cooperation was secured on a comprehensive scale. Among the governmental agencies assisting were: United States Coast Guard, Navy Department, War Department, Forest Products Laboratory, Bureau of Lighthouses, Bureau of Fisheries, Coast and Geodetic Survey and Chemical Warfare Service. Other cooperating organizations included the American Railway Engineering Association, American Association of Port Authorities, Harvard University, Massachusetts Institute of Technology, University of California, American Museum of Natural History and the Smithsonian Institution. Funds amounting to more than $50,000 were contributed by twenty-eight railroads, steamship lines and industrial companies. In addition to the organizations already mentioned, agencies of state and municipal governments, industries and harbor property owners over the world furnished services and materials. Two other divisions of the Council assisted in this work, namely, those of biology and agriculture, and chemistry and chemical technology.

As a consequence of this coordinated investigation, accurate knowledge is now available of conditions existing in all our ports on the Atlantic, Gulf and Pacific Coasts, including Alaska and our insular possessions. We know the habits of these borers, their life cycle, their breeding seasons, how to prevent their attack, how to preserve structures and also how to counter-attack. The completed report occupies a book of 534 printed pages and was widely distributed and used throughout the world as a reference book.

The Highway Research Board was organized in 1920 to assist in outlining a comprehensive program of highway research and to coordinate activities thereunder, to organize specific projects of highway investigation, and to act in a general advisory capacity.

The value of quasi-governmental standing of the Council is exemplified by the work of this board. The executive order of the President of the United States permits the Department of Agriculture to support and assist this project to a degree which would be impossible were it sponsored under other auspices. In this particular case total cash contributions from various sources have been more than $200,000. The wide-spread affiliations of the board are indicated by the fact that it has direct representation from every state highway department and many of the leading engineering colleges.

Time will not permit the review of other research projects completed or under way, such as those in heat transmission, electric and gas welding, molding sands and fatigue of metals under repeated stress. One special project quite different in character from the foregoing, the World Engineering Congress, is worthy of mention on account of its international character. The congress of 1929 was held in Japan under the auspices of the Kogakkai (Engineering Society of Japan) during the months of October and November. The purpose of these congresses, which are held at intervals of several years, is to advance and diffuse knowledge by presentation of papers and discussions on engineering subjects, to interchange views on various phases of professional engineering work, to promote international cooperation in the application of engineering science, and to cultivate a feeling of fellowship among engineers of the world.

The Division of Engineering and Industrial Research was selected by representatives of the American engineering societies to act as a sponsor body and to initiate activities on behalf of American engineers. Eighty papers by invited American authorities were prepared for the congress under this sponsorship, representing a cross-section of engineering developments in this country. The congress was personally attended by a large delegation from the United States, whose eminence in the profession reflected credit on American engineering and added to international friendships.

The promotional efforts of the division have been adapted in character and purpose to the state of industry. At the outset special attention was given to an exposition of the value of research in the industries. Activities at the present moment include, in addition to the above, special emphasis on "how to do research," on the promotion of research within trade associations for the benefit of their respective fields of industry and trade, and on fuller recognition of the university as a seat for the conduct of research in cooperation with industry.

Two domestic inspection tours of representative research laboratories have been sponsored and arranged for groups of industrial executives and bankers related to various fields of industry and from different geographical areas.

Eighty-five executives, including chairmen of boards, presidents, vice-presidents and general managers of industrial corporations and financial institutions, participated in the first one (1930). The general plan of organization, the type of problems selected for the research laboratory and methods used in their solution were studied. The importance and benefits to the particular industry derived from each laboratory were also discussed. These laboratories were mostly those maintained by large individual companies, but the tour program included the U. S. Bureau of Standards and the laboratory of a trade association.

The second tour of research laboratories was patterned after the first, but emphasized the significant feature that industrial research is not an affair exclusively for large companies. Under the critical financial conditions prevailing in the autumn of 1931, it is significant that nearly sixty representative industrial executives and bankers participated in this tour. While the number was not so large as in the previous tour, the geographical representation from as far west as the Pacific Coast and as far south as New Orleans demonstrated appreciation of the opportunities afforded by these tours.

Encouragement of research by trade associations has included the presentation of suitable addresses before association meetings, arrangement for key executives and research committees to visit successful research laboratories, suggestions as to the formation of research committees, the type of problems to be selected for study, the financing of the research projects, and the selection of laboratory facilities. Such assistance has been rendered to the textile, fisheries, brick and clay, glass-container, motion-pic-

ture, porcelain-enamel, steel-construction and aviation industries. A great deal of work remains to be done in this field.

Recognizing the need for promotional efforts designed to demonstrate "how to do research," the division sponsored the preparation of a book entitled, "Profitable Practice in Industrial Research." Fourteen distinguished men in science and in scientific research collaborated in the preparation of this volume, thus making available their experience and achievement in the development of a technique in industrial research.

In order to carry out effectively its promotional efforts, the division has found it necessary to keep at hand various types of information which may be useful to those who are considering the establishment of research laboratories or their proper administration. Examples of these are: bibliographies, surveys, plans for laboratory layouts and the book, "Profitable Practice in Industrial Research."

SCIENTIFIC EVENTS

THE INDUSTRIAL FELLOWSHIPS OF MELLON INSTITUTE DURING 1932–33

THE past fiscal year of Mellon Institute, ended February 28, 1933, covered a period of commercial dullness throughout the country. Notwithstanding the severe depression, however, the industrial fellowship activities in the institution were just as extensive and important as in 1931–32.

During 1932–33, 67 fellowships—18 multiple and 49 individual fellowships—were in operation, on which the services of 109 fellows and 28 assistants were required. At the close of the year 55 fellowships—14 multiple and 41 individual fellowships—were active, and 83 fellows and 15 assistants held positions thereon. Twenty-six fellowships have been at work for five years or more, and of this number 14 have concluded 10 years of research and nine fellowships have been operating for 15 years or longer.

In the last fiscal year $616,360 was received by the institute from fellowship donors to defray the cost of scientific investigations carried on for these companies and associations. The money appropriated by donors to the institute during the past twenty-two years amounts to $8,893,378.

Nine new fellowships began operation during 1932–1933, and 12 fellowships concluded their investigational programs in that year. During the calendar year 1932, 2 bulletins, 40 research reports, and 27 other papers were contributed to the literature by members of the institute. Forty U. S. patents and 62 foreign patents were issued to fellows. The total publications for the twenty-two years ended December 31, 1932, have been as follows: 18 books, 107 bulletins, 653 research reports, 961 other articles and 485 U. S. patents.

Many notable advances were made by the fellowships of 1932–33, and releasable facts regarding this investigational progress are presented in the twentieth annual report of the director, Dr. E. R. Weidlein, to the institute's trustees. Especially noteworthy were the research accomplishments of the industrial fellowships on air pollution, coke, commodity standards, food varieties, organic synthesis, packaging, petroleum production, protected metals, shoes and sugar. A large number of new products were developed and many of them were introduced commercially by fellowship donors. The urgent necessity for reviving business has been spurring many manufacturers to try through scientific investigation to evolve novel commodities as well as to improve their plant and merchandising practises. Throughout 1932–33 the very enthusiastic cooperation of donors in need of research results has expedited the work of their fellowships.

In addition to the numerous strictly technologic investigations of its fellowships and the constantly productive activities of its department of research in pure chemistry, the institute is studying the economic and social aspects of industrial research. Staff members of the organization are also aiding unemployed scientific men and engineers in securing professional posts, and are advising and encouraging the many companies that appeal to the institution for technical assistance.

The construction of the institute's new building is being continued despite prevailing business conditions. By the end of 1932 about 80 per cent. of the limestone had been set in place in the exterior, and during the subsequent two months practically all this work was completed. So far 235,000 cu. ft. of limestone and 22,000 cu. ft. of granite have been used, and only a very small amount of stone remains to be placed at the four corners of the edifice. The interior mechanical work is progressing, and it is thought now that the institute can occupy the building in the summer of 1934.—W. A. HAMOR.

THE MORRIS ARBORETUM OF THE UNIVERSITY OF PENNSYLVANIA

THE Morris Arboretum in Chestnut Hill, which was bequeathed to the University of Pennsylvania by the late Miss Lydia Thompson Morris, will be

formally dedicated at exercises to be held there on Friday, June 2.

On Saturday there will be a private viewing of the arboretum by officers and members of various horticultural societies and by others actively interested in the promotion of horticulture, and on Sunday the arboretum will be opened for the first time for inspection by the public.

The program for the dedicatory exercises on June 2 will be opened with a scientific session to be conducted at the arboretum at 11 o'clock, with Dr. Thomas S. Gates, president of the university, presiding.

At this session addresses will be made by President Gates; Dr. Rodney H. True, chairman of the department of botany at the university and director of the arboretum; Dr. A. H. Reginald Buller, professor of botany at the University of Manitoba, and Dr. Robert A. Harper, who is Adrian professor emeritus of botany at Columbia University.

Following the scientific session, officials of other well-known arboretums, distinguished scientists and men prominent in various other fields, who will be among the university's guests, will attend a buffet luncheon at the arboretum.

At a convocation to be held there at 3 o'clock on the afternoon of June 2 an address will be delivered by Dr. A. Lawrence Lowell, president of Harvard University, and three honorary degrees will be conferred. In addition there will be a brief ceremony during which custody of the arboretum will be formally transferred to the university.

Preceding the convocation, over which President Gates will preside, will be a formal academic procession. The Rev. W. Brooke Stabler, chaplain of the university and Boardman lecturer on Christian ethics, will give the invocation, and the ceremony of transferring custody of the arboretum will follow.

In this ceremony Maurice Bower Saul, attorney, will represent the executors and trustees of the Morris estate, while President Gates will accept custody of the arboretum on behalf of the university.

At the conclusion of his address, the degree of doctor of laws will be conferred upon President Lowell, and the degree of doctor of science upon Dr. Buller and Dr. Harper, speakers at the morning scientific session.

For the private viewing on Saturday, June 3, the arboretum will be open from 10 A. M. until 5 P. M. For the public inspection on Sunday it will be open from 1 to 6 P. M.

The Morris Arboretum, which overlooks the picturesque Whitemarsh Valley, consists of two estates of approximately 160 acres upon which Miss Morris, who died on January 24, 1932, and her brother, the late John T. Morris, developed one of the finest collections of botanical specimens in the United States. One of these estates, "Compton," where Miss Morris made her home, lies in Philadelphia County, while "Bloomfield," the adjoining estate, is situated in Montgomery County. Compton includes about eighty-five acres of highly diversified land with hillsides and valleys and several small streams. The original estate on which the residence now stands was first planted by Mr. Morris, but subsequently additional land was purchased and on this land later plantings were made by Mr. Morris and, after his death in 1915, by Miss Morris.

In addition to bequeathing the arboretum to the custody of the university, Miss Morris also left the residue of her property, after certain bequests, to constitute an endowment for the arboretum's maintenance and development.

THE FOURTH ANNUAL CONFERENCE OF DONORS AT THE JOHNS HOPKINS UNIVERSITY

THE donors of the fellowships established under the National Fellowship Plan of the Department of Chemistry of the Johns Hopkins University held their fourth annual conference at the university on May 5. The program for the day included addresses by Dr. C. E. Kenneth Mees, director of the Eastman Kodak Company, and Dr. Irving Langmuir, Nobel Laureate in Chemistry. Discussion of the fellowship plan, and visits to the research laboratories of the fellowship students also played a part in the program.

Dr. Joseph S. Ames, president of the Johns Hopkins University, opened the meeting in the morning. In the afternoon, discussion of the fellowship plan centered especially about the following points: the value of the selection of candidates by personal interview; the present research work of the fellowship men, and a comparison of the careers of those appointed for the fellowship and those not appointed, based on a statistical report which was drawn from questionnaires returned by the candidates of former years.

President Ames, at this time, announced the developments under the plan for the year 1932–33. He stated that the H. A. B. Dunning Fellowship for Maryland, given by Dr. Dunning, of Baltimore, and the F. G. Donnan Fellowship for England, given by Dr. Walter A. Patrick, have been endowed. Dr. A. R. L. Dohme, of Baltimore, has renewed for a four-year period his lectureship established to bring noted scientists to lecture at the university.

At 2:30, Dr. C. E. K. Mees delivered a short address on "Scientific Research and Industrial Depression" over WBAL broadcasting station. Dr. Mees gave a more extended discussion of this same topic at the university at 4:00. In his address, he sought to defend scientific research against the charge that "the

troubles of the modern world are really due to the advance of science."

The evening program of the conference was opened by a dinner at the Baltimore Country Club, given by President Ames in honor of the donors, the chemistry faculty and the speakers of the occasion.

Concluding the program for the day, Dr. Irving Langmuir, who recently received the Nobel award in chemistry, gave an exposition of recent research in the field of "Two Dimensional Gases, Liquids and Solids." His topic was of especial interest to advanced chemists and physicists.—N. E. G.

SYMPOSIUM ON THE PHYSICS OF NUCLEI AND OF HIGH ENERGY RADIATIONS

THERE was held from May 11 to 26 at the Norman Bridge Laboratory of Physics of the California Institute of Technology at Pasadena, a symposium on "The Physics of Nuclei and of High Energy Radiations," with the following program:

"Some Considerations on Cosmic Rays," Professor P. S. Epstein.
"The Free Positive Electron," Dr. C. D. Anderson.
"The Foundations of Atomic Mechanics," Professor Niels Bohr, of the University of Copenhagen.
"A Review of the Experimental Evidence for Neutrons," Professor C. C. Lauritsen.
"The Foundations of Atomic Mechanics," Professor Niels Bohr.
"Artificial Disintegration of Nuclei," Professor E. O. Lawrence, of the University of California.
"Recent Cosmic Ray Observations," Dr. H. V. Neher.
"The Foundations of Atomic Mechanics," Professor Niels Bohr.
"Spontaneous Nuclear Decomposition," Dr. R. M. Langer.
"The Foundations of Atomic Mechanics," Professor Niels Bohr.
"The Absorption and Scattering of High Energy Radiations," Professor J. R. Oppenheimer.

In addition to his participation in the symposium, Professor Bohr delivered a general lecture on the subject, entitled "'Explanation' in Natural Science." In this lecture he described the gradual change which the idea of mechanical explanation has undergone and the general outlook to which we are led regarding the problems in biology and psychology.

CONFERENCE ON THE DIFFUSION OF SCIENTIFIC KNOWLEDGE

THE summer meeting of the American Association for the Advancement of Science in Chicago will give opportunity for a unique gathering that deserves the special attention of scientific men. This is a Science Service Conference on the Diffusion of Scientific Knowledge which will be held on Friday, June 23. It will partake of the character of an international conference in which distinguished scientists from other countries will participate. It is hardly necessary to comment on the importance of the widest and most effective possible dissemination of information concerning advances in the scientific field. A few facts regarding the origin and general plan of the symposium will be of interest.

Last January the executive committee of Science Service sought to determine the most appropriate way in which that institution could cooperate with the association and the Century of Progress in the Chicago meeting. Out of that discussion came a plan to hold a conference on the diffusion of scientific knowledge with contributions from representative scientists of the various countries participating in the meetings. The value of such a conference was so clear that the officers in charge of the Chicago program enthusiastically approved the idea. The executive committee of Science Service requested its chairman, Dr. W. H. Howell, to arrange the symposium and to secure speakers from among the foreign guests representing the Scandinavian countries, England, France, Germany and Italy. In this way it is hoped to present a picture of methods employed in various parts of the world to bring scientific research before the public, and to provide an opportunity for scientific men from different countries to express their views in regard to the purposes to be sought and the means to be used in the popularization of science.

The speakers at the conference will include: Professor Joseph Barcroft, professor of physiology, University of Cambridge; Professor Niels Bohr, director of the Institute for Theoretical Physics, Copenhagen University, Copenhagen; Professor Filippo Bottazzi, professor of physiology, University of Naples; Professor Jean Dufrénoy, director of the Station of Agricultural Pathology, Brive (Corrèze), France; Professor Robert A. Millikan, director of the Norman Bridge Laboratory of Physics, California Institute of Technology. Dr. J. McKeen Cattell, president of Science Service, will preside at the conference.

The Science Service conference will be held at a luncheon meeting at the Hotel Stevens, on Friday, June 23, at 12:45 P. M. An invitation is extended to all interested to attend. Tickets will be obtainable at the American Association for the Advancement of Science registration booth, upon arrival in Chicago.—W. H. H.

SCIENTIFIC NOTES AND NEWS

DR. FRANK SCHLESINGER, director of the Yale University Observatory, has been elected a correspondent of the Paris Academy of Sciences in succession to the late Professor H. H. Turner, of Oxford, England.

DR. HARVEY CUSHING, who was until his retirement last year Moseley professor of surgery at Harvard University, was presented with the Bigelow Medal by the Boston Surgical Society on May 3, for his "contributions to the advancement of surgery." Previous recipients of the medal have been: 1921, Dr. William J. Mayo, Rochester, Minnesota; 1922, Dr. William W. Keen, Philadelphia; 1926, Dr. Rudolph Matas, New Orleans; 1928, Dr. Chevalier Jackson, Philadelphia; 1931, Professor George Grey Turner, Newcastle-upon-Tyne, England, and 1932, Dr. John M. T. Finney, Baltimore.

DR. CARROLL C. PRATT, of the department of psychology of Harvard University, was among those recently elected fellows of the American Academy of Arts and Sciences in Class IV, Section 1, which includes theology, philosophy and psychology.

AT the recent Montreal meeting of the Electrochemical Society the Edward Goodrich Acheson Medal was awarded to Dr. Colin G. Fink, of Columbia University. Lawrence Addicks, chairman of the medal committee, in presenting his report stated that the award was made to Dr. Fink on account of his record of distinction as an original investigator, as an inventor and as a teacher of electrochemistry. The formal presentation of the medal will take place at the fall meeting of the society, Chicago, September 7 to 9, 1934.

Popular Astronomy notes that Sir Frank Dyson and Lady Dyson were recently guests of honor at a complimentary luncheon in recognition of the effective service Sir Frank had rendered during a period of twenty-three years as astronomer royal of England and of his attainments and achievements in astronomy. Speeches of congratulation were made by Professor F. J. M. Stratton and Dr. W. A. Parr, presidents, respectively, of the Royal Astronomical Society and the British Astronomical Association.

DR. ARTHUR E. MORGAN, president of Antioch College and president of the Dayton-Morgan Engineering Company, has been appointed by President Roosevelt to be chairman of the Tennessee Valley Power Authority, the supervisory body which is to direct the development of Muscle Shoals.

FRANK W. PECK, director of extension of the department of agriculture of the University of Minnesota since 1921, has been appointed to the staff of the federal farm board under its chairman, Henry Morgenthau, Jr. He has applied to the university regents for a year's leave of absence to take up this work.

WATSON DAVIS, since 1923 managing editor of Science Service, has been elected director. This position has been vacant since the death in 1929 of Dr. Edwin E. Slosson, the first director. The following officers of Science Service were reelected at its recent annual meeting: Dr. J. McKeen Cattell, *president;* Dr. W. H. Howell, *vice-president* and *chairman of the executive committee;* Harry L. Smithton, *treasurer;* Watson Davis, *secretary;* Dr. C. G. Abbot and Marlen Pew, *members of the executive committee.*

DR. DEAN LEWIS, surgeon-in-chief of the Johns Hopkins Hospital, will be installed as president of the American Medical Association in Milwaukee on June 12.

THE new officers for 1933–1934 of the Electrochemical Society elected at the Montreal meeting are: Dr. John Johnston, of the U. S. Steel Corporation, *president;* H. S. Lukens (University of Pennsylvania), E. F. Cone (of *Iron Age*) and S. G. Blaylock (Trail, B. C.) *vice-presidents;* S. D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering,* O. W. Storey, Chas. F. Burgess Laboratories, Inc., and T. F. Baily, Alliance, Ohio, *managers;* Dr. Robert M. Burns, of the Bell Telephone Laboratories, *treasurer,* and Dr. Colin G. Fink, of Columbia University, *secretary.* The Weston Fellowship ($1,000) for 1933–1934 was awarded to Mr. R. D. Blue, a graduate of the University of Indiana. The Electrochemical Society's annual prize to young authors went to Frank W. Godsey, Jr., of New Haven, for his paper on "Electrolytic Condensers."

THADDEUS MERRIMAN, chief engineer of the New York City Board of Water Supply, has been elected president of the Metropolitan Section of the American Society of Civil Engineers. David B. Steinman, consulting engineer, was elected vice-president, and Jacob S. Langthorn was chosen treasurer. Arthur G. Hayden, William W. Brush and E. M. Van Norden were elected directors.

NEWLY elected officers of the University of Cincinnati Chapter of Sigma Xi are: *President,* Dr. Shiro Tashiro, professor of biochemistry in the Medical College; *Vice-president,* Dr. Robert A. Kehoe, director of the Kettering Laboratory; *Secretary-treasurer,* Dr. Saul B. Arenson, associate professor of inorganic chemistry, College of Engineering and Commerce; *New Members of the Nominating Committee,* Dr. Chas. N. Moore, department of mathematics, and Dr. D. A. Wells, department of physics.

MR. CHARLES AUGUSTUS CARLOW was elected president of the Mining Institute of Scotland at the recent annual meeting.

DR. GEORGE F. BUCHAN has been elected chairman of the council of the Royal Sanitary Institute for the session 1933–34, in succession to Dr. Charles Porter, whose term of office has expired.

A GRANT of $500 has been made from the Marsh Fund of the National Academy of Sciences, under which M. K. Elias, of the Kansas Geological Survey, will carry on field studies of fossils of western Kansas, Nebraska and South Dakota. Dr. Elias will begin the field work in Cheyenne, Rawlins, Rooks and Graham Counties.

MISS ANNE HEYMAN was awarded the first prize of $300 for her paper, "The Bacteriology of Goiter," by the American Association for the Study of Goiter at its annual meeting, which was held in Memphis, Tennessee, from May 15 to 17. The prize is awarded annually for the best paper based on original research on any phase of goiter. The present investigation was carried out in the Hygienic Laboratory at the University of Michigan under the supervision of Dr. Malcolm H. Soule.

THE American Medical Association has made a grant to the Research Department of the Barnard Free Skin and Cancer Hospital of St. Louis, to support studies, under the direction of Dr. M. G. Seelig, of the carcinogenic action of scarlet red and dibenzanthracene 1:2:5:6.

THE Daniel-Pidgeon fund for 1933 of the Geological Society of London has been awarded to Mr. J. D. Solomon, for work on the correlation of the Pleistocene deposits of southeastern England with those of the Continent.

THE Carnegie Corporation has recently voted $30,000 to the Research Grant Board of the Union of South Africa to support specific scientific research projects which may be selected by the board. This grant from the corporation's special fund (applicable elsewhere than in the United States) supplements a previous grant of $50,000 voted in 1927. The membership of the board is as follows: Professor Robert B. Young, *chairman;* Sir Spencer Lister; Professor L. Fouche; Dr. J. McCrae, and Dr. P. J. du Toit. Among the projects already carried out are: Lepidoptera of South Africa, by Dr. A. J. T. Janse; Engraved Stones of Bechuanaland and Griqualand West, by Miss M. Wilman; Music and Musical Practises of the Native Peoples of South Africa, by Professor P. R. Kirby.

DR. CURT STERN, of the Kaiser Wilhelm Institut, who has been in this country since 1932, is working temporarily at the laboratory of the Carnegie Institution at Cold Spring Harbor, New York.

DR. PEDRO ARA, formerly director of the Anatomical Institute in Cordoba, Argentina, now of Madrid, Spain, is visiting the United States.

DR. PIERRE LECOMTE DU NOÜY, chief of biophysical chemistry at the Pasteur Institute, Paris, sailed for the United States on May 18. He will be in charge of the Pasteur Institute exhibit at the Chicago exposition.

DR. C. G. ROSSBY, professor of meteorology at the Massachusetts Institute of Technology, will return from Europe early in June, after an absence of eight months, during which he studied the latest advances in modern European meteorological methods.

DR. WALTER STRAUB, professor of pharmacology at the University of Munich, was a recent guest of Dr. Harvey B. Haag, professor of pharmacology at the Medical College of Virginia, Richmond. Dr. Haag worked in Dr. Straub's laboratory several years ago in Munich.

DR. JOHN H. VAN VLECK, professor of theoretical physics at the University of Wisconsin, will give this summer a course of lectures on "The Recent Developments in the Theory of Magnetism" at the University of Michigan.

DR. FREDERICK L. HISAW, professor of zoology at the University of Wisconsin, was the guest speaker at the final meeting of the year of the Iowa Section of the Society for Experimental Biology and Medicine held at the State University of Iowa on May 12. Dr. Hisaw addressed the society on "Hormones Influencing the Primate Endometrium."

MARQUETTE UNIVERSITY has announced the appointment of Dr. Edward J. v. K. Menge, director of the department of zoology, to be international guest lecturer to the national universities of Poland for the summer of 1933. He will deliver a series of six lectures interpreting the science and philosophy of America in its relations to the science and philosophy of Slavic and Latin countries. In 1927 Dr. Menge was international guest lecturer to the national universities and learned societies of Brazil, Uruguay, Argentina and Chile.

BY invitation of the senate and academic council of the University of London, Professor William King Gregory will give a series of lectures on the evolution of man at University College at the end of May. Professor Gregory sailed for England on May nineteenth and will return about the middle of June.

DR. J. BJERKNES, director of the Geophysical Institute, Bergen, Norway, who is the guest of the Century of Progress Exposition and of the American Association for the Advancement of Science for the Chicago meeting, will give a series of lectures on the stratosphere at the Massachusetts Institute of Technology early in June. Dr. Bjerknes is also expected to lecture at the University of Toronto.

PROFESSOR HENRY FAIRFIELD OSBORN sailed on May 19 for a brief visit abroad. Arriving in London on May 25 he expects to read before the Royal

Society of London a paper entitled "Principles of Biomechanical Evolution, Observed in Fossil Mammalia"; on May 29, at a regular weekly session of the Académie des Sciences of the Institut de France, the same communication will be made in French with the title "Aristogenèse, le Nouveau Principe Inductif d'Evolution Biomécanique." These two addresses are the tenth and eleventh in a series on the Origin of Species; the ninth, "Aristogenesis, the Observed Order of Biomechanical Evolution," was presented to the National Academy of Sciences on April 25. Professor Osborn's Aristogenesis conclusions are the results of his scientific observations, chiefly on titanotheres and proboscideans, for the past forty-five years. Returning to England on May 30, Professor Osborn will spend the four days before his departure on June 3 in reexamining the famous Piltdown specimens in the British Museum and comparing with the originals the drawings that were prepared for him by Miss Barbara Hopkins; he hopes also to return with Mr. J. Reid Moir to the Piltdown and Foxhall localities, to make further study of the geology of these regions, in preparation for his forthcoming revision of "Men of the Old Stone Age."

THE one hundred and eighty-sixth regular meeting of the American Physical Society will be held at Chicago from June 19 to 24, as a joint meeting with Section B of the American Association for the Advancement of Science. On Monday morning, June 19, there will be sessions for the reading of contributed ten-minute papers. The remainder of the week will be devoted to symposia, public lectures and other forms of entertainment connected with the Century of Progress Exposition. The titles of the symposia are: "Applications of Quantum Mechanics in Chemistry"; "Isotopes"; "Age of the Earth"; "Applications of Spectroscopy in Astronomy"; "Nuclear Disintegration." Among distinguished foreign guests will be: F. W. Aston, Niels Bohr, J. Bjerknes, J. D. Cockcroft, Madame Curie, E. Fermi and A. Sommerfeld. They will participate in the symposia together with members of the American Physical Society.

THE sixth power show at Chicago previously scheduled for the Coliseum will be transferred to the Exhibition Hall of the Stevens Hotel, the center of "Engineering Week" activities of the Century of Progress. This change in location will permit the engineering profession visiting Chicago to visit the show while attending their meetings, and brings together the "Engineers' Day" banquet and the exhibit in the same building. Approval of participating in "Engineering Week" of the World's Fair has been given already by 19 engineering associations. Others will also participate. The organizations cooperating are as follows: American Association for the Advancement of Science, American Association of Engineers, American Ceramics Society, American Foundrymen's Association, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Municipal Engineers, American Society for Testing Materials, American Society of Agricultural Engineers, National Council of State Boards of Engineering Examiners, Society for the Promotion of Engineering Education, Society of Industrial Engineers, Institute of Radio Engineers, Western Society of Engineers, American Society of Refrigerating Engineers, American Welding Society, National Industrial Advertisers Association, National District Heating Association.

AT the annual meeting of the District of Columbia Chapter, Society of the Sigma Xi, held on May 9, Lyman James Briggs, acting director of the National Bureau of Standards; George Walter McCoy, director of the National Institute of Health, and Matthew William Stirling, chief of the Bureau of American Ethnology, Smithsonian Institution, were presented as members-elect, and an illustrated address was given by Dr. Paul Bartsch, curator of the division of mollusks, Smithsonian Institution, who presented some of the results of his recent exploration of marine life in the deeps near the West Indies. The president-elect for the coming biennium is Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution.

THREE new buildings have been erected at Bear Mountain for the Trailside Museum of the American Museum of Natural History, which opened for the season on May 1. The buildings were erected by the Commissioners of Palisades Interstate Park under direction of William A. Welch, general manager and chief engineer, and John Tamsen, park superintendent. The wooden craft-house and garage were replaced by buildings of native stone, and a new Geology Trailside Museum, also of native rounded boulders, was built. The new museum will house exhibits of minerals and rocks of the region, relief models, reference collections and a library. New stone steps and bridges have been built along the trail at several points, a new approach has been made to Geology Point overlooking the Hudson River, and more parking space and other improvements have been added.

WORD has been received that the preparation of the English manuscript of the International Rules of Botanical Nomenclature adopted at Cambridge in 1930 has been completed. This draft was sent to Germany and France about February 1 for translation. It is expected that these rules will be published during 1933.

DISCUSSION

FLUORESCENCE OF CELLS IN THE ULTRA-VIOLET

THE corpse-like appearance of human skin due to fluorescence in the ultra-violet is familiar to all who recall the mercury lamps formerly used in photography.

Fluorescence of living tissues may have been observed long ago, but it was not understood until after Stokes explained the nature of fluorescence in physical systems in 1852.[1] As early as 1855 Helmholtz[2] had made a careful study of fluorescence of the lens of the eye and considered the wave-lengths 3000–4000A most effective in producing fluorescence. Hertel[3] in 1905 showed that fluorescence of the cornea of the rabbit and of human skin is apparently strongest at 2320A, less distinct from 2320 to 2800A, rather feeble at 3830A, but can be detected even in the visible light at 4480A through a yellow-green filter which absorbs all the reflected 4480A. In 1909 Schanz and Stockhousen[4] reported that fluorescence of the lens of the eye begins in the blue, is more intense in the violet, and becomes most intense in the ultra-violet between 3700 and 4000A, with a maximum at 3850A. Walker[5] summarizes studies on the fluorescence of eye tissues. Stübel[6] in 1911 studied the fluorescence of a great number of other tissues, tissue products, protozoa, bacteria and various organic materials in light screened to give the wave-lengths 3000–4000A. He finds that the color of fluorescent light for different tissues varies from yellow to blue.

It seems of interest to report fluorescence of Paramecium, Oxytricha and a bacterium in the monochromatic light of the wave-lengths of the quartz mercury arc.

Paramecium multimicronucleata and Oxytricha fallax, cultured on a 0.1 per cent. lettuce infusion, were concentrated by centrifuging gently, washed in a balanced salt solution,[7] and again concentrated by centrifuging. They were then pipetted into a quartz-faced cell. Observations were made through a binocular microscope (20x) at right angles to the incident beam of light coming through a quartz monochromator from the arc.[8] The whole set-up was enclosed in a black drape to exclude stray light during observations.

The protozoans fluoresced at all the ultra-violet lines used. At 3660A the fluorescence was of a pale greenish gray shade. At 3350, 3130 and 3020A the color was more of a pale greenish blue. At 2804 and 2654A the protozoans fluoresce with a more whitish light, and as they dart into the beam of light appear like so many fireflies on a dark summer's night. At 2537A the color was again a pale greenish blue. Varying the size of the slit to change the intensity of the lines employed showed that at about equal intensities of incident radiation, fluorescence was of maximal intensity at 2804 and 2654A, of lesser but comparable intensity at 2537, 3020 and 3350A, and apparently minimal at 3130 and 3660A. The intensity of fluorescence was merely judged by the effects upon the eye of the observer.

A pseudomonad bacterium isolated from a lettuce infusion was observed in suspension in the quartz cell placed in the beam of ultra-violet light. A pale blue-green fluorescence occurred throughout the range of ultra-violet wave-lengths, but as the individual bacteria could not be seen in the set-up used, the degree of fluorescence at different wave-lengths could not be compared.

Hertel[3] states that the cornea ceases to fluoresce on death. Renschler[9] says Paramecia killed by the arc light fail to fluoresce. To determine whether death is always followed by cessation of fluorescence, protozoan cells were killed in several ways. Coagulated rapidly by the full light of the arc excluding only the heat, Paramecia showed decreased fluorescence. Killed by low intensities of monochromatic ultra-violet radiation, the Paramecia cytolized rapidly. The medium then became highly fluorescent and it was impossible to determine the nature of fluorescence of partially cytolized Paramecia or of the protoplasmic fragments. Coagulated by adding a few drops of 1.0 N HCl to the cell, the Paramecia showed greatly decreased fluorescence with apparent extinction at 3660A. But when heated until they just coagulated and studied in the ultra-violet light, Paramecia showed slightly increased fluorescence at 2537 and 2654A and little change from 2804 to 3660A. It appears then that fluorescence, of dead protozoan cells at least, depends upon the method employed in killing.

Fluorescence is chiefly of interest as one of the secondary processes following excitation of the electrons in the molecules of protoplasm by absorption of radiation. It will be noted that the abiotic wave-lengths (3000A and shorter) are strongly fluorescent. Part of the energy absorbed is emitted as light of longer wave-lengths probably without producing photochemical effects. Therefore fluorescence should

[1] Stokes, *Phil. Trans.*, p. 558, 1852.
[2] Helmholtz, *Pogg. Ann.*, 94: 205, 1855.
[3] Hertel, *Zeitschr. f. Allgem. Physiol.* 5: 95, 1905.
[4] Schanz and Stockhausen, *Arch. f. Ophthal.*, 73: 561, 1909.
[5] Walker, *Proc. Am. Acad. Sci.*, 51: 760, 1915–1916.
[6] Stübel, *Pflüger's Arch. f. d. Ges. Physiol.*, 142: 1, 1911.
[7] Barker and Taylor, *Physiol. Zool.*, 4: 620, 1931.
[8] Leighton and Blacet, *Jour. Am. Chem. Soc.*, 54: 3165, 1932.
[9] Renschler, SCIENCE, 73: 480, 1931.

be taken into account in any quantitative theory of the effects of ultra-violet light.

A. C. GIESE
P. A. LEIGHTON

STANFORD UNIVERSITY

THE BORON CONTENT OF SEA WATER

DURING the last few years the concentration of boron in sea water has been the subject of a great deal of interest and not a little speculation on the part of workers concerned with certain phases of oceanographic chemistry. Attention to this element has been directed principally by a number of investigations of the buffer mechanism, *i.e.*, the factors that determine and regulate the hydrogen-ion concentration of sea water. In this mechanism are involved the salts of the various weak acids known to occur in sea water, namely, carbonates, bicarbonates, phosphates, arsenates, silicates and borates. However, according to the information available until very recently, only the salts of carbonic acid, and in a few localities also the silicates, are present in sufficient quantity to require notice in studying the buffer system. Nevertheless, it has been found that the behavior of the buffer mechanism in sea water is not in accord with the theory of carbonate solutions, even when allowance is made for the activity of the ions of the strong electrolytes present. To explain this discrepancy the possibility of the occurrence of buffer salts other than those of carbonic acid in appreciable quantities has been considered but, as previously stated, this possibility has not been supported by the existing analytical data. For the phosphate, arsenate and silicate reliable data have been available for a number of years, but for the borate content only one value has been reported, namely, in 1877 by Dieulafait[1] who estimated that water from the Mediterranean contains approximately 0.0002 g. per liter of boron. This is equivalent to about 0.02 millimoles of boric acid, a quantity of no significance in the buffer mechanism, since it is only 1 per cent. of the molar concentration of the total carbon dioxide.

There was also reason to suspect that the boron content of sea water varied considerably with locality because in 1859 Veatch[2] reported to the California Academy of Sciences that he had detected boron in water from along the coast between San Diego and the Strait of Juan de Fuca, but not in water from beyond fifty or sixty miles off the California coast. He found boron most abundant toward the South and concluded that in certain localities it enters the sea from submarine volcanic sources. The absolute quantities of boron found were not indicated.

[1] L. Dieulafait, *Comptes Rendus*, 85: 605–608, 1877.
[2] J. A. Veatch, *Proc. Calif. Acad. Sci.*, 2: 7, 1859.

The reason that the concentration of boron in sea water has not been adequately investigated long ago is that until recently there has been no satisfactory method for its determination. In 1932 Foote[3] described a titration method suitable for determining small quantities of boron in water but this was soon thereafter modified by Wilcox[4] who used a quinhydrone electrode for detecting the titration end-point. Foote also determined the boron content of a sample of sea water from Ventura, California, and found it to be 4.27 parts per million.

In this laboratory the electrometric titration method of Wilcox has been used, with minor modifications necessitated by the difference in salt content between sea water and the water for which the method was developed, for analyzing about fifty samples of sea water obtained from various depths from the surface down to 500 meters off La Jolla and to 3,200 meters near the Hawaiian Islands and from the surface in several other localities, including northern California and Tortugas, Florida. In these samples the boron content varied from 4.30 to 4.80 mg. per kilogram, the average being close to 4.50 mg. This variation corresponded very closely with the variation in the salinity of the water, the average ratio between boron and halides being 0.000239, or, stated in other words, boron constitutes about 0.013 per cent. of the total solids in sea water. As boric acid this corresponds to about 0.4 millimoles per liter or, if boric acid is regarded as monobasic, to nearly 20 per cent. of the equivalent concentration of all the weak acid radicals present.

It is therefore probable that boron compounds play an important part in regulating the hydrogen-ion concentration of sea water and that some of the conclusions drawn from previous studies of the buffer system will need to be revised. These matters will be discussed in a subsequent paper.

E. G. MOBERG
M. W. HARDING

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA

PERSISTENT STRANDS OF THE ROOT-ROT FUNGUS IN TEXAS

THE ability of the cotton root-rot fungus, *Phymatotrichum omnivorum* (Shear) Duggar,[1] to remain in the soil in a viable and infectious condition for a period of years, even when the fields are planted to

[3] F. J. Foote, *Ind. and Eng. Chem., Anal. Ed.*, 4: 39–42, 1932.
[4] L. V. Wilcox, *Ind. and Eng. Chem., Anal. Ed.*, 4: 38, 1932.
[1] B. M. Duggar, "The Texas Root-Rot Fungus and Its Conidial Stage," *Ann. Missouri Bot. Gard.*, 3: 11–23, illus., 1916.

nonsusceptible crops or kept in clean fallow, has been a question of much concern to investigators of this disease.

A partial solution of this problem was afforded when King and Loomis[2] announced the discovery of a sclerotial stage of the fungus in 1929. In the same year Dana[3] described the occurrence and infectious nature of smooth or "horse hair" strands following an 18-month clean fallow. Ratliffe[4] also reported upon a prolonged saprophytic stage of the fungus, which had hitherto been regarded by some as an obligate parasite.

During the years of 1931 and 1932 opportunity was afforded on the U. S. Cotton Breeding Field Station at Greenville, Tex., to further study the habits of the fungus in nature. Extensive searches in the soil for the source of carry-over infection was made in a number of infested plots which had been handled under different cropping and tillage conditions, and therefore permitted at least a minimum estimate as to the age and nature of the carry-over infection.

The colloidal nature of the Wilson and Houston clay soils, in which the examinations were made, presented an unusual opportunity for studying both the fungus and plant root development in their natural state of growth. An examination of a very large number of primary centers in continuous cotton plots in 1931 and 1932 revealed the fact that the carry-over infection was not due entirely to sclerotia and that the most of the infection over-wintered in the soil as strands rather than in the sclerotial stage. Examinations in a plot which was in clean fallow for the first year yielded numerous viable strands throughout the summer and fall of 1932. These strands were located, as a rule, along the old dead roots of the plants that they had destroyed the year before, or previously.

On a plot which had been in oats in 1930 and 1931, and kept in clean fallow after the crops were harvested, viable old strands were found throughout the summer of 1932, in and near primary centers of infection. These strands were found *in situ* upon the decayed remains of the old cotton roots which they had destroyed three years or more before. In some cases they were occupying the empty root channels of former plantings. When these strands were removed from the soil and placed in moist chambers, they readily put out new growth. Old strands found interlacing a colony of sclerotia in a plot which had been in clean fallow for 5 years were also viable. The age of the strands associated with colonies of sclerotia can not be determined accurately as they may have been the product of regenerated growth, from the original colony, subsequent to the fallow treatment.

The growth of the hyphae which usually took place from the ends of the old strands was characterized by radiating or parallel growth of elongated cells which freely anastomose during the early growth stages. As this growth developed, the conjugation of cells became less frequent and the more typical type of acicular hyphae with right-angled branches appeared. Histological studies showed that the older strands possessed an outer corticle ring of thick-walled, irregular shaped cells inside of which were large, elongated, thin-walled, septate cells. In younger strands the elongated cells may be smaller and the corticle layer very rudimentary or even absent.

The knowledge that strands of the root-rot fungus, in addition to the sclerotia, remain in a viable and infectious condition in the soil for several years, is worthy of note. In contrast to the more deeply seated infections of the far southwest, the strands at Greenville, Texas, were found most abundant in the surface foot of soil which render them more accessible to tillage operations or to soil disinfectants.

HOMER C. MCNAMARA
R. E. WESTER
K. C. GUNN

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE
GREENVILLE, TEXAS
November 17, 1932

[2] C. J. King and H. F. Loomis, "Further Studies of Cotton Root-Rot in Arizona with a Description of a Sclerotium Stage of the Fungus," *Jour. Agr. Research*, 39: 9, p. 641–676, illus., 1929.

[3] B. F. Dana, "Recent Development in Root-Rot Investigations," *Farm and Ranch*, 48 (46): 22–23, 1929.

[4] G. T. Ratliffe, "A Prolonged Saprophytic Stage of the Cotton Root-Rot Fungus," U. S. Dept. Agr. Circ., 67, 8 pp., illus., 1929.

THE MOST NORTHERN OCCURRENCE OF MESQUITE ON THE GREAT PLAINS

IN 1897, while collecting invertebrate fossils from the Comanche Cretaceous in southern Kiowa County, Kansas, I found a small shrub about five feet in height, which at that time was unknown to me. The next year, 1898, Dr. Lester F. Ward, the noted phytopaleontologist whom I was then assisting in collecting dicotyledonous leaf impressions from the Cheyenne sandstone, identified this shrub as mesquite (*Prosopis*). This was, I believe, the first and, so far as I am now aware, the only recorded occurrence of mesquite growing in Kansas.

The location is in the so-called "Black Hills," about four miles southeast of Belvidere, and ten miles west of Sun City. More specifically, it is in the southeast corner of Township 30 South, Range 16 West, at about 37° 20′ north latitude. Dr. Ward's interpretation of this mesquite growing so far from its natural

habitat was that seeds had been carried by cattle from Texas.

The mesquite tree, which reaches its maximum size along Rio Grande River in western Texas and northern Mexico, is quite abundant in southwestern Oklahoma, especially in the counties bordering Red River south of the Wichita Mountains, where it sometimes reaches the size of 10 inches in diameter and 20 feet in height. It occurs sparingly as far east as Coal and Atoka counties, Oklahoma, being found on the prairie between the eastern end of the Arbuckle and the western end of the Ouachita mountains. It also occurs in central Oklahoma as far north as southern McClain County. Both these locations are in the drainage of Washita River.

Queerly enough, mesquite is very rare, if indeed present at all, in the drainage of the two Canadian rivers in the western part of Oklahoma. But it is found in the valley of Cimarron River north of the Canadians in the northwestern part of the state. It is especially abundant in canyons and slopes of the Gypsum Hills and in the flat lands at the foot of these hills south of Cimarron River in Blaine, Major and Woodward counties, where thousands of acres are covered with dense growths of the shrub which here rarely becomes more than eight feet in height. So far as observed, it does not here occur among the sand hills.

Mr. R. C. Tate, a local naturalist of Kenton, Oklahoma, has reported numerous specimens of mesquite shrubs along Cimarron River and its tributaries in northwestern Cimarron County, which is the westernmost of the three counties which make up the Panhandle of Oklahoma, originally known as No Man's Land or the Neutral Strip.[1]

For some years Mr. Tate has been searching for the mesquite in southern Colorado, and under date of November 17, 1932, writes me that he has finally located a specimen about a quarter of a mile north of the Colorado line, in section 15, Township 35 South, Range 49 West. This is in Baca County, 49 miles west of the southeast corner of Colorado and in latitude 37° north.

Tate also reports clumps of mesquite along Carrizo Creek in northeastern New Mexico. The location is section 15, Township 30 North, Range 35 East, about 12 miles west of the Oklahoma line, and about the same distance south of the Colorado line.

It is altogether possible that the plant may occur along the Big Bend of the Cimarron River in Morton, Stevens, Grant or Seward Counties in southwestern Kansas. If in Grant County, the locality may be farther north than the lone shrub which Dr. Ward and I found near Belvidere, southern Kiowa County, 34 years ago.

It would appear that the greater number of observers are inclined to agree with Ward that the seeds of mesquite have been carried northward by cattle. However, it might not be amiss at this time to place on record an observation by the late Colonel Charles Goodnight, famous plainsman and rancher, one of the first men to successfully raise buffalo in captivity. In his opinion the seeds were carried by wild horses or mustangs, rather than by cattle or buffalo. Colonel Goodnight, who was an unusually close observer, is reported to have said that he had frequently noted small mesquite shrubs spring up near piles of horse manure at points far distant from the natural habitat of the plant.

However, the most vexing problem is, why is the mesquite so rare, if not entirely absent, in the valley of both North and South Canadian rivers in western Oklahoma, and so abundant along the tributaries of Cimarron River still farther north? Plant ecologists please answer.

CHAS. N. GOULD

UNIVERSITY OF OKLAHOMA

SPECIAL CORRESPONDENCE

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

IN a review of the 1932 activities of the Academy of Natural Sciences of Philadelphia recently issued, Charles M. B. Cadwalader, managing director, depicts its 121st year as one of marked advances, and calls special attention to new exhibits, a large increase in museum attendance and continued scientific exploration in many parts of our own and other lands.

"We have shared the common decrease in income and contributions," says Mr. Cadwalader, "but have not lessened our efforts to give Philadelphia a free natural history museum of the first order, and to continue the laboratory research that has made the academy world known. During the year we kept the museum open every day, without any change in hours, and we had 113,300 visitors, a 9 per cent. increase over 103,700 in 1931, and nearly three times as many as in 1930. Among these were 2,900 in special classes from Philadelphia schools; 2,200 from private and public schools in New Jersey, Delaware and the metropolitan area, 1,000 Boy Scouts, who entered their names in the register provided for them, and 600

[1] "Some Observations on the Spread of Mesquite to the North in Cimarron County, Oklahoma," *Proceedings* of the Oklahoma Academy of Science, Vol. VIII, 1928, p. 58.

pupils from the School of Industrial Art in the regular Saturday sketching classes.

"Two new animal life-groups, with backgrounds painted by C. Clark Rosenkranz, were opened—one of musk-oxen from East Greenland, the expedition and group a gift from R. R. M. Carpenter, a trustee of the academy; and one of swans from Currituck County, North Carolina, presented by Mrs. Charles W. Henry. We now have eight of these striking exhibits in North American and African Halls, and five additional ones are in course of construction. These include the remarkable giant sable antelope from Angola, West Africa, gift of Prentiss N. Gray, a trustee of the academy; also the rare giant panda from Szechuan Province, China, and the takin, a strange cattle-like mountain antelope from western China, both presented by Brooke Dolan, whose expedition collected the specimens. Two others, now partially completed, await further financing—a waterhole group of fifteen East African animals, which will be the largest in the museum, and a group of American bison, with four unusually fine specimens presented by General Harry C. Trexler, a trustee of the academy.

Additional birds needed for the half-completed display of those found in and near Philadelphia have been secured. This exhibit, which is so popular with school children, teachers and nature lovers, can be finished as soon as funds are provided.

In Mineral Hall was installed the first of a series of instructive exhibits, this one answering the question, "What is Geology?" Other additions include modern cases given by Effingham B. Morris, for effective showing of spectacular minerals; a large "ringing rock" from Bucks County, Pennsylvania; a section of the Kilbourn meteorite, and a clear crystal ball cut from a mass of quartz found in Logan, Philadelphia.

The seventeen expeditions sponsored by the academy included several of outstanding importance. Brooke Dolan, who headed an expedition to western China and Tibet, returned after eighteen months' absence with 200 mammals, 900 birds and numerous mollusks, many of them rare and nearly all new to the academy's collections, the largest and most valuable representation ever received from that part of the world.

M. A. Carriker, Jr., accompanied by H. Radclyffe Roberts, continued his bird survey of Peru, returning from his fourth expedition with 2,000 specimens. Dr. Witmer Stone says: "The importance of this work consists not only in making an inclusive collection of Peruvian birds and discovering new varieties in regions hitherto unexplored by naturalists, but also in securing data on distribution to aid in determining places of origin of the various types. It will shed further light on the development of the Andes Mountains, for our knowledge of the earth's past history is derived quite as much from such sources as from geology."

Other expeditions were as follows: Mr. and Mrs. Rodolphe M. de Schauensee to Siam, and Mr. and Mrs. Sidney J. Legendre to Indo-China, both for birds and mammals; W. Judson Coxey, a fifth expedition to Ecuador for butterflies and moths; Mrs. J. Norman Henry and Miss Josephine deN. Henry to British Columbia for plants, minerals and insects; Miss Mary G. Henry to the famous Meteorite Crater in Arizona; Edgar B. Howard to New Mexico for fossil remains; Wharton Huber to New Mexico for birds and mammals; James Bond, a sixth expedition to the West Indies for birds; Samuel G. Gordon to Canada for minerals; Arthur N. Leeds to Florida for ferns; Bayard Long and Dr. Walter M. Benner to the Carolinas and Georgia for plants, and Dr. and Mrs. Francis Harper to the Okefinokee Swamp in Georgia for plants.

More than 65,000 specimens of mammals, birds, mollusks, insects, moths, butterflies, fishes, reptiles, minerals and plants were added to the laboratory collections, which now total more than 7,000,000 specimens.

Using Cape May, New Jersey, as a base for continued study of bird migration, Dr. Witmer Stone, curator of vertebrate zoology, found an explanation of the curious northward flight of certain birds on their southward autumnal journey. His observations indicate that strong northwest winds at that season cause the birds to fly into the wind to prevent being blown out to sea. When they find feeding grounds, they delay their passage over the wide Delaware Bay until the winds abate.

Henry W. Fowler, curator of fishes and reptiles, completed the sixth and seventh volumes of his monumental work on "The Fishes of the Philippine Seas and Adjacent Waters."

Dr. Henry A. Pilsbry, curator of mollusks, discovered that the Florida pond snails do not serve as temporary hosts to the human blood fluke which causes Schistosomiasis, a serious malady spreading throughout the tropics. Comparing specimens secured by the recent expedition to the Everglades with those from Puerto Rico and the Caribbees, he found that they do not belong to the same genus, as was previously believed.

Mr. Cadwalader calls attention to the inadequacy of funds for maintenance and staff in the academy's library, which now contains 120,000 volumes. He also

emphasizes the valuable services rendered during the year by the following voluntary workers: Miss Margaret N. Robins, Miss Mary Allison Reed, Miss Virginia C. Beggs, Mrs. Emmett R. Dunn, Jean Piatt, Miss Betty Shryock, Mark H. C. Spiers, Joseph Wood, Jr., Miss Anne Harbison, Ernest L. Bell, Cyrus H. Chappell, Walter S. Cosgrove, J. W. R. Rehn, Russell M. Wood, Don M. Benedict, William R. Keeney, Mrs. Francis Harper, Edward R. Barnsley, Miss Anne Wistar Comfort, Horace J. Hallowell, Miss Josephine deN. Henry, Miss Mary G. Henry and George Vaux.

A total of 4,500 members and visitors attended the meetings of the seven natural history organizations associated with the academy—the Delaware Valley Ornithological Club, the Philadelphia Mineralogical Society, the Philadelphia Botanical Club, the Leidy Microscopical Club, the American Entomological Society, the Pennsylvania Fish Culturists' Association, and the Pennsylvania State Fish and Game Protective Association.

Fenimore Johnson was elected a member of the board of trustees.

REPORTS

MEDALS PRESENTED AT THE ANNUAL DINNER OF THE NATIONAL ACADEMY OF SCIENCES

THERE has been printed in SCIENCE the names of those to whom the medals of the National Academy of Sciences were presented at the Washington meeting. The following statement gives some information concerning the medallists and concerning previous awards of the medals.

Alexander Agassiz Medal for Oceanography: Awarded to Albert Defant, of the Institut für Meereskunde, Berlin, Germany, for his studies on atmospheric and oceanic circulation and his notable contributions to theoretical oceanography. This medal is provided through the Murray Fund, a gift from the late Sir John Murray to found the Alexander Agassiz gold medal for the awarding of medals to scientific men in any part of the world, for original contributions to the science of oceanography. Ten previous awards have been made, as follows: Johan Hjort, 1913; Albert I, Prince of Monaco, 1918; C. D. Sigsbee, 1920; Otto Sven Pettersson, 1924; Vilhelm Bjerkness, 1926; Max Weber, 1927; Vagn Walfrid Ekman, 1928; J. Stanley Gardiner, 1929; Johannes Schmidt, 1930; Henry Bryant Bigelow, 1931.

Public Welfare Medal: For eminence in the application of science to the public welfare—awarded to William Hallock Park, of New York City, for his work as head of the research laboratories of the New York City Department of Health as a pioneer and leader both in research and in the application of scientific discovery to the prevention of disease. This medal is provided for from the Marcellus Hartley Fund, established in 1913–14 through the gift of Mrs. Helen Hartley Jenkins, in memory of her father, Marcellus Hartley. Ten previous awards have been made, as follows: G. W. Goethals, 1914; W. C. Gorgas, 1914; Cleveland Abbe, 1916; Gifford Pinchot, 1916; S. W. Stratton, 1917; Herbert Hoover, 1920; C. W. Stiles, 1921; Charles V. Chapin, 1928; Stephen Tyng Mather, 1930; Wickliffe Rose, 1931.

John J. Carty Medal and Award for the Advancement of Science: Awarded to John Joseph Carty, a member of the academy, since deceased, in whose honor the medal was established for his distinguished accomplishments in the field of electrical engineering, particularly as they have influenced the development of electrical communication, and also his noteworthy influence on the introduction of fundamental science and of the methods of sound scientific research as an integral and powerful tool of industrial development. This is the first award of the Carty Medal, which was established by the American Telephone and Telegraph Company in November, 1930, in recognition of Mr. Carty's noteworthy contributions to science and as a testimonial of the esteem in which he is held by his associates in the Bell System. The terms of the gift provide that the awards shall be made to an individual, for noteworthy and distinguished accomplishment in any field of science coming within the scope of the National Academy of Sciences; either for specific accomplishment in some field of science, or for general service in the advancement of fundamental and applied science.

Henry Draper Medal: Awarded to V. M. Slipher, Lowell Observatory, Flagstaff, Arizona (a member of the academy), in recognition of his spectroscopic researches, among the most important of which may be mentioned: (1) The discovery of "stationary" calcium lines in stellar spectra; (2) the development of efficient methods of observations of the spectra of spiral nebulae and the securing of the first observations of their radial velocities; (3) observations of bright lines and bands in the spectra of the night sky. This medal is made possible through the Henry Draper Fund, established by gift of Mrs. Henry Draper in 1883, in memory of her husband, a deceased member of the academy. Twenty-one previous awards of this medal have been made, as follows: S. P. Langley, 1886; E. C. Pickering, 1888; H. A. Rowland, 1890; H. K. Vogel, 1893; J. E. Keeler, 1899; Sir William Huggins, 1901; George E. Hale, 1904; W. W. Campbell, 1906; C. G. Abbot, 1910; H. Deslandres, 1913; Joel Stebbins, 1915; A. A. Michelson, 1916; W. S. Adams, 1918; Charles Fabry, 1919; Alfred Fowler, 1920; Pieter Zeeman, 1921; H. N. Russell, 1922; A. S. Eddington, 1924; Harlow Shapley, 1926; William Hammond Wright, 1928, and Annie Jump Cannon, 1931.

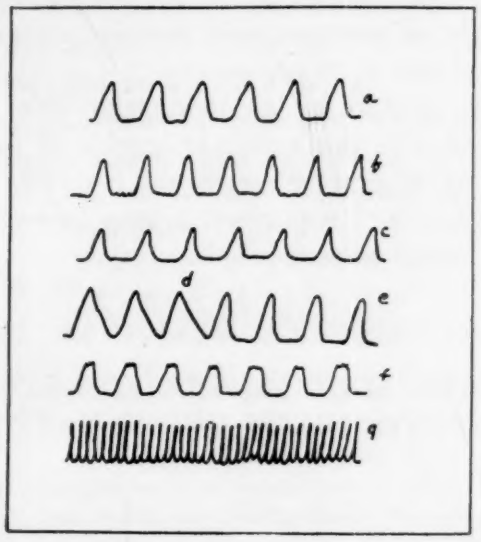
Mary Clark Thompson Medal: Awarded to Francis Arthur Bather, of Wimbledon, England, for his distinguished services in the fields of paleontology and geology. His principal scientific contributions are his Crinoidea of Gotland, published in Stockholm in 1893, his work on the Triassic echinoderms of Bakony in 1909, his chapters on echinoderms in Lankester's treatise on zoology, his contribution on the Cystidea from Girvan in 1913, and his studies in the Edrioasteroidea in 1915. These are in addition to many other papers on geological and biological subjects covering the field of fossil invertebrates though relating mainly to crinoids. He also has made important contributions on museum technique. The Mary Clark Thompson Fund, which makes the award of this medal possible, was established by gift of Mrs. Thompson in 1919. Seven previous awards have been made as follows: To Charles Doolittle Walcott, 1921; Emmanuel de Margerie, 1923; John Mason Clark, 1925; James Perrin Smith, 1928; William Berryman Scott, 1930; Edward Oscar Ulrich, 1930, and David White, 1931.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

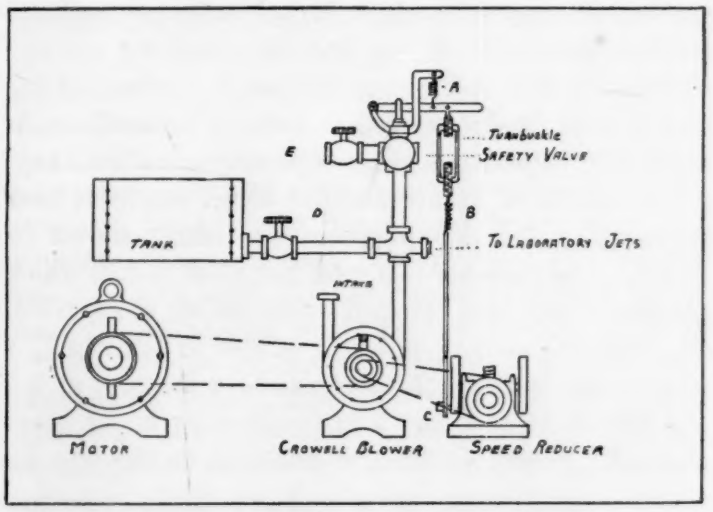
AN APPARATUS FOR MAINTAINING ARTIFICIAL RESPIRATION IN LABORATORY ANIMALS

SOME mechanical device for carrying out artificial respiration in laboratory animals is practically an indispensable piece of equipment in the physiological laboratory. It has not been long since experimenters resorted to hand or foot bellows for the performance of this necessary procedure. These have been gradually replaced by more elaborate mechanical machines, in which the volume and rate of the output may be varied as desired. One of the most popular methods particularly for student experiments, employs an ordinary wind-shield wiper as a means of interrupting a current of air. In some laboratories motor-operated rotary valves are inserted in the air-line leading to the laboratory tables. Still others find it practical to equip each mammalian group with special apparatus for instituting artificial respiration. As desirable as this seems, the facilities of many laboratories do not permit such an expenditure, and therefore, recourse is made to some of the simpler and less expensive methods, except where certain research problems are involved.

For more than eight years the simple device described in this article has been in use in this laboratory, and having given most satisfactory service with practically no attention, it is reported here for whatever value it might be to other laboratories. The Crowell blower, designed for volume output, is probably more desirable than other types of air pumps which are capable of higher pressures. There is little danger of rupturing the lungs from the full pressure exerted by many of these rotary blowers. The tank placed in the line acts as a buffer and serves to regulate the degree of lung inflation, as well as governing the rate of inflation with respect to the total duration of the respiratory phase. As a means of interrupting the current of air an ordinary safety valve, in the line, as shown in the accompanying diagram, is readily adapted. This valve is mechanically operated by a rod connecting to cam C on the speed-reducing gear. The tension of spring H is so adjusted that the



safety valve is held open when the cam is in the "up" position, and the air output of the blower escapes through valve E. The turnbuckle, by adjusting the tension of spring B, regulates the time of closing and opening of the safety valve. By increasing the tension on this spring the safety valve remains closed through a greater arc in the revolution of the speed reducer, and therefore prolongs the inspiratory phase. Valve E regulates the rate of de-



flation or the duration of the expiratory phase. No special valves in the main air line leading to the laboratory tables are necessary, since the resistance of this line is so much greater than through the safety

valve, the pressure at the laboratory jets drops practically to zero when the safety valve is opened. By regulating the opening of the air cocks on the laboratory table, the volume of air delivered can be varied according to the requirements of the animal. It may be found necessary, when experiments are conducted simultaneously on a large number of animals, to slightly close valves E and D, and to increase the tension on spring B. The respiratory rate is regulated by means of step pulleys on the motor or pump shaft. Inexpensive reducing gears of 48:1 ratio are available from most dealers in laboratory equipment. A further reduction of 2:1 for motors operating at 1750 R.P.M. is necessary, and gives an approximated respiratory rate of 20 per minute.

That the method for maintaining artificial respiration described in this article is capable of producing a variety of respiratory curves, and is readily adapted to most laboratory requirements, may be readily seen from the accompanying graphs.

W. R. BOND

MEDICAL COLLEGE OF VIRGINIA

A SPECIAL AIR-CHAMBER FOR STUDYING PHOTOSYNTHESIS UNDER NATURAL CONDITIONS

IN studies of photosynthesis under natural conditions with the apparatus recently described by Heinicke and Hoffman,[1] the use of a Cellophane or plastacele envelope as a leaf chamber has distinct advantages over larger containers. However, when the leaf is exposed for a prolonged period to the direct rays of full sunlight, the temperature within the envelope, as in all chambers in which the leaf is wholly enclosed, may rise 6 to 10 degrees C. above that prevailing outside.

This difficulty can be avoided with the apple and with other species in which the stomates are confined to the lower side of the leaf by attaching an air-chamber to that side only. The upper surface of the leaf is thus freely exposed to entirely natural conditions with respect to light, temperature and humidity.

The details of an air-chamber which has been used successfully for this purpose are clearly shown in Fig. 1. The chamber is a modified glass funnel which contains a side arm through which the air is supplied. The leaf (B) rests upon a soft rubber or felt rim (C) which extends a few millimeters above the edge of the cup (D).[2] It is firmly held in place by a flat brass ring (A), which in turn is attached to the cup by means of spring clamps (G). The tension of these clamps can easily be adjusted so that the pressure will be sufficient to prevent the free passage of air, but not enough to injure the leaf tissue. The cup is held in position by means of a wire test-tube holder which is attached to the twig or other support. It may be left in place for several days or even for weeks at a time.

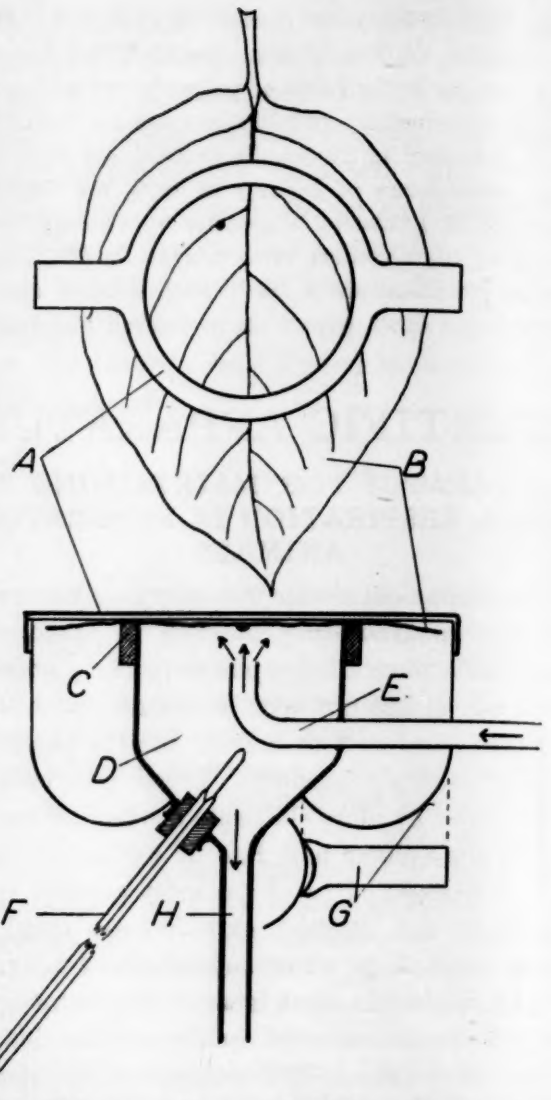


FIG. 1. Diagram of an assimilation chamber used in studies of photosynthesis. The top view is shown above; the cross-section below. The brass ring (A) is used to hold the leaf (B) against rubber cushion (C) of glass cup (D). Air supplied through (E), exhaust through (H). Thermometer, at (F). Top view of spring clamp leading from ring to bottom of cup, at (G).

The fresh air supply is drawn through a glass tube from the side arm (E) which extends from about 10 cm outside the cup to the middle of the chamber. The end of the tube inside the cup is bent so that the leaf lies parallel to and about 1 cm above the opening. The air thus circulates near the under side of the leaf tissue before it passes through the narrow tube at the bottom of the funnel and thence to the absorption towers.

A similar chamber can easily be made without special technique in glass blowing. This consists of

[1] A. J. Heinicke and M. B. Hoffman, SCIENCE 77: 55–58, 1933.

[2] When the rim is coated with a thin layer of soft grafting wax the contact between the leaf and the cup becomes air-tight. The device may thus serve as a porometer for studying the relative size of stomatal aperture at different periods of the day.

a piece of glass tubing of the desired diameter and about 4 cm long. A 3-hole rubber stopper is inserted in one end, and the other end is fitted with a narrow piece of soft rubber tubing, which furnishes a cushion for the leaf. The center hole of the stopper is for the glass tubing through which the fresh air can be supplied. The thermometer is inserted in the second hole and the third will accommodate the exhaust tube. This tube may be bent in such a way that it can be attached to the stem by means of friction tape and thus support the air-chamber.

For convenience in calculating the results, the diameter of the glass tube from which the air-chambers are made should be carefully chosen, so that the area of the opening is exactly 1/10, 1/7, 1/5, or any simple fraction of 100 sq. cm. The inside diameter of the brass ring which holds the leaf in position corresponds to the opening of the cup. The activity of a definitely limited area is thus determined so that it is unnecessary to measure the total leaf surface. Where the same area is used, the air supply can be accurately regulated and held constant in successive determinations. This is important if the carbon dioxide supply is not to become a limiting factor in the results. Where the suction available is not sufficient to supply at least 2 L of air per hour for each sq. cm of leaf surface, an air-chamber with smaller diameter may be used.

The results obtained with these cup chambers have been slightly higher on the average than those obtained with the Cellophane envelopes. This may be due to the fact that no account is taken of the gaseous change that might occur through the upper surface of the leaf, but mainly to the fact that excessively high temperatures are avoided and that the air supply is always adequate for maximum rates.

A. J. HEINICKE

CORNELL UNIVERSITY

THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING. III.

(*Continued from page 496*)

Recent studies on chemical mediation of nerve impulses: W. B. CANNON. Previous studies by Cannon and Bacq proved that a substance, which they called "sympathin," is given off from smooth muscle when it is stimulated by sympathetic nerve impulses. Sympathin is carried in the blood stream and has sympathomimetic effects on denervated structures (salivary glands and cardiac and smooth muscle) elsewhere in the body. Adrenin likewise has sympathomimetic effects; it has been assumed that sympathin is the same as adrenin. The present investigation has shown that sympathin differs from adrenin and that two kinds of sympathin are produced: one from smooth muscle when made to contract, that causes elsewhere only motor or excitatory effects, sympathin E; the other from smooth muscle when made to relax, that causes elsewhere only inhibitory effects, sympathin I. These observations introduce a new phase in our knowledge of chemical mediation of nerve impulses.

Studies on the function of the adrenal cortical hormone and the cause of death from adrenal insufficiency in dogs: W. W. SWINGLE (introduced by E. G. Conklin). The chief function of the adrenal cortical hormone appears to be the regulation and maintenance of a normal circulating volume of fluid within the vascular system. In the absence of the hormone, fluid is continually lost from the circulation, presumably by transudation through the capillary walls, with the result that the adrenalectomized animal is unable to maintain his normal blood volume, and eventually dies from circulatory collapse due to insufficiency of circulating fluid. Accompanying the progressive decrease in blood volume is a progressive fall of blood pressure to the death level. The decline in arterial pressure is apparently a direct result of the decreased volume of circulating fluid. The decrease in blood volume and blood pressure are not terminal phenomena in adrenalectomized animals but first appear within twenty-four to seventy-two hours after discontinuing hormone injections, and before active symptoms of insufficiency appear. Both volume and pressure steadily decline to the death point which may not occur until eight to twelve days later. Hemoconcentration, decreased renal activity, rise in blood non-protein and urea nitrogen, increased blood viscosity and the marked slowing of the circulation which invariably appears, are all directly correlated with and chiefly dependent upon the decline in plasma volume and blood pressure. Adrenalectomized animals, in the absence of the cortical hormone, are apparently unable to draw fluid back into the blood stream through the capillary walls. Following administration of adequate amounts of cortical hormone to prostrate animals, the blood volume, blood pressure and blood constituents return to normal. The animal is able to dilute its blood and build up a normal blood volume and all symptoms of adrenal insufficiency disappear. It is our opinion that all of the manifestations, symptoms and physiological peculiarities, which have been described as occurring in adrenalectomized animals are merely results of a progressively failing circulation due to decreasing volume of circulating fluid in an animal which is unable to compensate (as do normal animals) for its low blood volume and blood pressure by dilution.

The progressive degeneration of nerve: G. H. PARKER and V. L. PAINE. When the lateral-line nerve of the

catfish, Ameiurus, is cut near its origin in the fish's head, the nerve degenerates over its whole distal length. If degeneration in the medullary sheath and the neurofibrils is studied, the process is found to take place progressively, beginning near the degenerative cut and spreading away from the region of injury. Degeneration progresses over the nerve at a rate of from three to five centimeters per day and is best seen between six and thirteen days after the degenerative cut has been made. Progressive degeneration of nerve is contrary to the ordinarily accepted view which is based, for the most part, on a study of nerve in warm-blooded animals. Here the rapidity of the process makes it difficult to observe the real operation which is better studied in such a cold-blooded form as the catfish.

Concerning reticulo-endothelial cells and the utilization of the magnet to procure them: PEYTON ROUS and J. W. BEARD. Fixed on the walls of the blood vessels of certain mammalian organs are peculiar cells, usually termed reticulo-endothelial, which rapidly remove bacteria from the circulation and destroy them. They also remove damaged blood corpuscles and injected particulate matter, becoming greatly engorged therewith on occasion. It is supposed that these cells constitute a physiological system having various important activities; but of this there is no certainty, because the cells have appeared to be inaccessible to direct study. The authors find that they can be obtained alive from deeply anesthetized animals by injecting particles of highly magnetic ferric oxide into the blood stream; loosening the iron-containing cells afterwards from their principal situation, within the liver, by means of massage and a stream of fluid; and selecting them from the host of other elements in suspension by means of an electromagnet. The reticulo-endothelial cells so procured flourish under suitable conditions outside of the body and behave characteristically, manifesting their recognized activities. Experiments to test their presumptive functions are under way.

Human insensible perspiration as a laboratory and clinical measurement: FRANCIS G. BENEDICT. The ordinary person sitting quietly loses in weight about 30 grams per hour, due chiefly to the vaporization of water from the lungs and skin. This insensible loss in weight, the so-called "insensible perspiration," is closely correlated with the total heat production, and hence varies with the size of the individual and with the metabolism. This measurement has important relations to studies in so-called "water balance" and is of significance in cases where the metabolism can not be measured directly. Thus its use for estimating the total heat production of people for twenty-four hours has been of great value.

Primary and secondary 1n+1 types, a new unbalance in the jimson weed: A. F. BLAKESLEE, S. SATINA, A. D. BERGNER and A. G. AVERY. Among the plants of *Datura stramonium* growing in the greenhouse this past winter, there were two small individuals which resembled haploids (1n) in appearance, but which at the same time had peculiarities suggestive of the known effects of extra chromosomes in certain primary and secondary 2n+1 types. Their preliminary classification as 1n+1 forms has been confirmed cytologically by finding 13 chromosomes in pollen-mother-cells and root tips instead of the 24 characteristic of normal diploids (2n). Judging from appearance, the first type has the primary 15.16. If this is true, we have identified four types with characters brought about by unbalance of this 15.16 chromosome extra and its formula would be 1n+15.16. The series in order of increasing unbalance would be 4n+15.16, with unbalance of 1 vs. 48; 2n+15.16 with unbalance of 1 vs. 24; 2n+2 (15.16), with unbalance of 2 vs. 24 (or 1 vs. 12); and 1n+15.16, with unbalance of 1 vs. 12. The second plant from appearance is probably a 1n+7.7 type. This haploid secondary, if it actually is a secondary, would have twice the numerical unbalance of the diploid secondary 2n+7.7, which was its female parent. It would have an unbalance of two .7 halves vs. 12, which is the most extreme unbalance so far secured in any type of Datura. It is hoped it will be possible to confirm the tentative classification of the extra chromosomes if offspring can be obtained from these extremely weak plants and if a sufficient number of pollen-mother-cells can be secured at the proper stage of division. Lesley and Frost have reported a haploid Matthiola with a small chromosomal fragment extra, but apparently these two 1n+1 plants in Datura are the first haploids to be reported with a whole chromosome extra.

Gene constitution and endocrine quality in determining growth reactions: C. R. STOCKARD. In various crosses between structurally contrasted pure breeds of domestic dogs localized structural peculiarities occur, resulting from the presence of one or more genes which determine a given structural pattern. The growth and pattern in one body region may be quite normal, while a modified pattern is developed in another region in spite of the same chemical or endocrine environment existing in the several regions. A significant example of these facts is shown in the inheritance and development of the short-twisted tail of the English bulldog when crossed with the long-tailed short-legged basset-hound. The bulldog-tail is transmitted as a double recessive in inheritance and its expression is related to two factors probably located in different chromosomes. The homozygous double recessive appears in the second generation in only one in sixteen individuals. Dystrophy in the cartilages of the skull and of the tail vertebrae in the bulldog might be thought of as similar reaction in the two separate regions to a common internal cause. However, some of the second generation hybrid individuals from crosses between the bulldog and basset-hound may show almost normal hound-like heads and yet possess the deformed short-twisted bulldog tail. Such individuals, homozygous for both recessive factors determining "screwtail," develop chondrodystrophy of the tail vertebrae in the same endocrine environment in which the skull and extremities grow and develop quite normally. This would seem to indicate that general endocrine conditions may be in-

effective in regulating the type of growth response in opposition to the genetic constitution. For illustration, ordinary individuals may not respond in their growth reactions to pituitary modification in the same manner as might those inheriting acromegaly.

Retinal rivalry as a neglected factor in stereoscopic vision: MARGARET F. WASHBURN. This paper argues that a neglected but important factor in stereoscopic vision is, not the combination of two slightly different images on corresponding points of the two retinas, but the alternation of these images in retinal rivalry. That rivalry occurs when the stereoscope is used is well known. This paper demonstrates (a) that it occurs in our ordinary perceptions of solid objects, a fact apparently hitherto unrecorded; and (b) that when similar figures, each containing all the lines of both the right and left views of a solid object, are combined by a stereoscope the figure looks flat, because rivalry is absent, although it contains all the retinal elements for a stereoscopic effect. Since solidity is itself primarily a motor experience, involving the movements of handling and grasping an object, it seems natural that it should be suggested not by a static fusion of retinal images but by an apparent movement. Rivalry occurs both in the stereoscopic slide and in ordinary vision, and as one eye's image becomes dominant over that from the other eye, the apparent movement produced is identical with that which would be produced by part of the object's approaching or receding in the third dimension.

The "spread" or "scatter" phenomenon in learning: EDWARD L. THORNDIKE. A satisfying after-effect of a mental connection works back upon it to strengthen it. But this confirming influence of a reward is not entirely concentrated on the one connection to which the reward belongs. The influence strengthens also neighboring connections in the series. Curves are presented showing the extent and amount of this "spread" or "scatter" for several representative sorts of learning. The significance of the discovery of this phenomenon for general theories of modifiability is discussed briefly.

Basic approaches to a science of music and speech: CARL E. SEASHORE. Our researches in the psychology of music have revealed the surprisingly close relationship between the science of music and the science of speech, which it is important to recognize in the further organization of research. The paper classifies the types of relationships which have been discovered through experiment, and, on the basis of these, outlines a program for a laboratory of phonetics devoted to the science of these two arts.

Aristogenesis, the observed order of biomechanical evolution: HENRY FAIRFIELD OSBORN. This is the author's ninth contribution on the problem of the origin of species and principles of biomechanical evolution observed in paleontology. The term "biomechanical" applies to organic mechanisms. No more apt term than "aristogenesis" can be applied to the observed order of biomechanical adaptation exemplified in the grinding teeth and horns of mammals, as closely observed during the past half century. Aristogenesis is a concrete principle; it has no theoretic significance such as the "entelechy" of Aristotle, the "pangenesis" of Darwin, the "vitalism" of Driesch, the "bathmism" of Cope, the "emergence" of Morgan, the "holism" of Smuts. Like the "biogenesis" of Haeckel signifying recapitulation, aristogenesis signifies adaptive origin. As a process of nature it is not to be challenged as a concept, still less as an explanation, hypothesis or theory. We know how it works, but at present we have no hypothesis as to why it works or as to what its causes are. A definition of aristogenesis is as follows: Aristogenesis is the gradual, secular, continuous, direct, reactive, adaptive origin of new biomechanisms. It is a creative process from the geneplasm, of entirely new germinal characters. It is the orderly creation of some better or more adaptive biomechanism. Certain lines of descent are distinguished by the potentiality of creative origin from the geneplasm of new adaptive biomechanisms. Germinally predetermined origin of new biomechanisms tends toward betterment, and arises independently, in widely separated geographic areas, at same or different aristogenic rates. Aristogenesis is a secular genetic and adaptive reaction rather than an immediate adaptive somatic reaction to new habit or environment as in Lamarck's theory. *Aristogenes* in origin and early development are wholly independent of the natural selection principle of Darwin. Whereas *Aristogenes* are predetermined by germinal potentiality, progressive differences in species arise also through more or less profound changes of form and proportion distinguished as *Allometrons* and expressed in measurements and indices, for example, in the familiar proportional changes of the head expressed in the Greek terms brachycephaly (broad-headed, index 80) and dolichocephaly (long-headed, index 70). Allometrons are relatively rapid in development or temporal, whereas aristogenes are relatively slow or secular. The 19 aristogenes of a lower Miocene mastodont occupy from 10 to 14 million years in rising to the 34 to 37 aristogenes of an upper Miocene mastodont. So far as the modes in which the "origin of species" is defined by biomechanisms we are now on absolutely sure ground. This ground is contra-Lamarckian and contra-Darwinian. It is also contrary to the neo-Darwinian evolutionary hypotheses of the leading biologists and geneticists of our day.

The general formula of heredity: HARRY H. LAUGHLIN (introduced by Henry Fairfield Osborn). Most inborn qualities, whether structural or functional, which are constitutionally important in human life, which are essential to well-bred domestic plants and animals, and which are therefore highly hereditary, are not single Mendelian units, nor are many of them based upon so few as two or three genes working additively. For the most part, each such valuable quality is the somatic end-product of many genes, which in development interact in many ways. Many such multi-genic traits are definitely measurable as end-products in the individual, and consequently we can compute the probability that the particu-

lar quality developed to a specified degree will appear in a pre-indicated or random-selected offspring. The basis of such prediction is the degree of development of the selected quality in each of the several near blood-kin. The traits or qualities which can be thus predicted may be structural or functional, vital or insignificant, useful or injurious, but they must be measurable as entities in the individual, and they must show a definite tendency to "run in families." For all such traits, the formula of heredity works out mathematically: $K = f(M, R)$. K is the probability that the pre-indicated or random-selected offspring, with a given M or prediction basis, will fall within the selected R or class range of offspring. The mathematical model of this formula is always a "skewed saddle."

Evidences of man's ancestral history in the later development of the child: C. B. DAVENPORT. It has long been known that man, in his foetal development, passes through many stages reminiscent of the course of the evolution of the human species. Thus tail, gill-slits, tubular heart, amphibian-like kidney, for example, are ancestral. It is less well appreciated that at birth the child is still far from an adult in proportions of parts, and has still to pass through a series of changes shown by adult primates. At birth of the child the chest is a cylinder of approximately circular cross-section. This is the shape of the chest of the foetus of other primates and many other mammals. It is the generalized, undifferentiated form of the chest. In running quadrupeds, like the gazelle and horse, the depth of the chest becomes greater than the breadth. But in man, the breadth becomes greater than the depth. The circular-cylindrical chest is rather characteristic of adult tree-climbers, and fits them for the undifferentiated movements required in climbing; for specialization in upright walking it is convenient that the arms swing free of the torso, and this result is attained in adult man's broad shoulders; but these broad shoulders are achieved relatively late in development. Again, the upper and lower segments of the leg of the human foetus are, in the early months, very unequal, since the thigh takes the initiative in rapid growth. This appears to be an undifferentiated condition. Later the lower leg grows rapidly so that it approaches equality with the thigh; that is, about 90 per cent. at eleven or twelve years. This is the condition that is rather characteristic of tree-climbers. After this pre-adolescent stage the femur forges ahead, and the leg index falls in the adult condition to about 84 per cent. This long thigh takes the adolescent out of the childish, ape-like class of climbing, jumping, romping animals into that of walkers and runners. The human foot shows remarkable adaptations to supporting the great weight of the body upon the spool-like talus and distributing that weight to the whole foot in the most efficient fashion. But the adaptive changes are completed only as adolescence appears. The infant has a rather low instep, like anthropoid apes. This instep increases to adolescence, and gives a valuable resilience to the step. The human fetal foot is at first long, as compared with the lower leg, just as in the anthropoid ape. This may be regarded as a generalized condition. In later months this foot index diminishes from 95 per cent. to 90 per cent.; in the adult boy to 65 per cent., while it remains at about 90 per cent. in the adult gorilla and chimpanzee. A long heel is a human characteristic. The foetus has a relatively short heel bone, a condition that is retained by adult chimpanzee and orang-utan, but the heel bone increases in childhood up to adolescence. The parallelism of ontogeny and the phylogenetic series is clearly due to the fact that the higher forms pass through the same embryological stages that the lower forms do, but they go beyond the point at which the less evolved species stop their development.

Racial aspects of the pathology of the ear: ALEŠ HRDLIČKA. The collections of the division of physical anthropology, U. S. National Museum, include now over 15,000 racial crania, over three fourths of which are American. This American material is largely precolumbian and comprises a number of series ranging from hundreds to several thousands of specimens, including the contents of entire large burial grounds, and these series are not only of great value to anthropology but also to the study of prehistoric American pathology. One of the most interesting categories of pathological conditions shown by the material comprises the defects and diseases of the bony ear structures. The present paper deals with the two most striking conditions of this nature, namely, a complete congenital absence of the external auditory meatus and apparently of the whole tympanic bone; and ear exostoses. In the present communication the speaker reports the results of personal examination for ear exostoses in 7,814 skulls, Egyptian, Eskimo, American Indian, Polynesian, Negro and Melanesian. The abnormalities are shown decisively to be most frequent in certain inland groups of the Indian, and next in the Polynesians. They are never congenital, and rare in childhood, developing essentially during the earlier half of the adult life. They are moderately to considerably more common in the males than in the females, more frequently bilateral than unilateral, and when unilateral they show a tendency to develop more commonly on the left side. They vary much in number, size and shape, and often show more or less symmetry on the two sides. They, the speaker concludes, are not incidental or chance formations, but represent a generalized pathological entity, an oto-exostotic diathesis, which manifests itself in different degrees in different racial and local human groups, according to local checking or favoring conditions.

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